State of Kentucky's Environment:

1994 Status Report

Prepared by:
Leslie A. Cole and
Peggy Pauley
with
Scott Richards and
Paula Nye

Environmental Quality Commission
Commonwealth of Kentucky

Published by:

The Kentucky Environmental Quality Commission
14 Reilly Road
Frankfort, Kentucky 40601-1132

February 1995

Individuals who wish to obtain this publication in a recorded format should contact:

The Kentucky Talking Book Library
P.O. Box 818
Frankfort, KY 40602
502-875-7000 or 800-372-2968

Printed with state funds on recycled paper with soy ink

Commonwealth of Kentucky
Brereton C. Jones, Governor

The Kentucky Environmental Quality Commission (EQC)
is a seven-member citizen board created under state law with a mission to:

- facilitate public discussion and resolution of environmental issues,
- monitor environmental trends and conditions,
- promote partnerships to improve and protect the environment for future generations,
- serve as an advisory board to state officials on environmental matters.

EQC Commissioners
Wm. Horace Brown, Chairman, Shelbyville
Gordon Garner, Vice Chairman, Louisville
Aloma Dew, Owensboro
Robert Riddle, Midway
Patty Wallace, Louisa
Harold Benson, Frankfort
Betsy Bennett, Lexington

EQC Staff
Leslie Cole, Executive Director
Peggy Pauley, Assistant Director
Scott Richards, Research Assistant
Paula Nye, Administrative Assistant

Cover Photos:
Blanton Forest—old-growth forest, albino Pink Lady's-Slipper (*Cypripedium acaule*) Harlan County, Kentucky

by Pam Spalding.

About the Cover

Blanton Forest covers 6,500 acres on Pine Mountain in Harlan County and is the largest tract of uncut old-growth forest in Kentucky.

The most significant statewide conservation effort in the history of the Commonwealth is now underway to purchase 2,350 acres of the forest. Initially, $500,000 in private funds must be raised to match the funds allocated by the 1994 General Assembly for the acquisition of part of the forest. In order to protect *Blanton Forest* as the state's largest nature preserve, $4 million must ultimately be raised, $1 million of which will establish an endowment for long-term protection of the area.

With private and public support, *Blanton Forest* will endure to enrich the lives of future generations. Donations to the *Blanton Forest Fund* are tax deductible as charitable gifts. To contribute or learn more about how you can help, contact Bob McCance or Marc Evans with the Kentucky State Nature Preserves Commission at 502-573-2886.■

Forward

As Chairman of the Kentucky Environmental Quality Commission, I am pleased to present the *State of Kentucky's Environment: 1994 Status Report* on behalf of Commission members and staff.

Two years have passed since the publication of the first *State of Kentucky's Environment* report and much has happened in terms of environmental quality. This report reveals that the state continues to make progressive strides toward achieving a healthy and sustainable environment.

These improvements are the result of environmental laws, public and private sector investments, as well as individual efforts to protect the environment. Many Kentuckians are doing their part by recycling trash and 3,600 groups have adopted 14,000 miles of highway to reduce roadside litter. Another 345 groups have adopted more than 300 waterways across the state to monitor and restore these resources.

Kentuckians should be justifiably proud of the accomplishments we have made. But the public recognizes that many challenges remain. In the 1994 Spring Poll conducted by the University of Kentucky, 91% of the people surveyed expressed medium to high concern regarding environmental issues in their community.

The *State of Kentucky's Environment: 1994 Status Report*, while showing much progress, reveals that bacteria pollution from human and animal waste is still a problem in many waterways making them unfit for swimming and other uses. Our drinking water infrastructure may require additional attention based on the fact that, in 1993, more Kentuckians were advised to boil their water than in any previous year due to potential contamination from water line breaks. Incidents of groundwater pollution continue to mount and more recently recognized threats such as toxic chemical releases to the air and water remain a concern. The natural diversity that makes Kentucky so unique has also been compromised, with 12% of the species in the state considered rare.

During 1994, under the leadership of Governor Brereton Jones and the Kentucky Legislature, a number of actions were taken to address some of these problems. Noteworthy among them was the passage of the **Environmental Leadership Act** which targets the reduction of toxic chemicals through cooperative public/private partnerships. The **Soil Erosion and Water Quality Cost-Share Fund** was established to assist farmers reduce soil erosion and manage livestock waste to prevent water pollution. And funding for the **Heritage Land Conservation Fund** will go a long way toward purchasing important natural habitats and preserving the state's biological diversity.

As the new Congress debates the merits of various federal laws and targets program reductions, the need to continually monitor environmental conditions in the state takes on even greater importance. Not only does this report provide Kentuckians with a barometer of environmental health, it also offers policymakers a tool to better focus limited state and federal program dollars on areas of greatest need. It is the Commission's hope that the *State of Kentucky's Environment: 1994 Status Report* and future assessments will help us to better comprehend environmental issues, set priorities and attainable goals, and work together to promote sound and effective solutions for a sustainable state.■

William Horace Brown, Chairman
Environmental Quality Commission

Contents

Introduction

Kentucky's environmental health is improving. Environmental laws and investments have paid off in cleaner water, air, and landscapes. But, as the *State of Kentucky's Environment: 1994 Status Report* also reveals, many problems remain. The Environmental Quality Commission was mandated by the Kentucky Legislature in 1990 to assess environmental conditions to determine if investments are achieving results and report these findings every two years. The Commission published the first environmental trends report in 1992. The 1994 report continues this effort, using indicators to measure environmental quality and identify successes as well as shortcomings.

The report includes factual information and a general analysis of data to determine environmental trends. An environmental profile of Kentucky provides a snapshot of the current health of our environment and natural resources. The profile is followed by a review of environmental trends and indicators contained in the report's seven chapters—water resources, air quality, waste management, toxic pollutants, natural resources, resource extraction, and energy. Each chapter includes a summary and highlights of the findings along with charts and graphs depicting information and data used to measure environmental quality. It should be noted that many charts and graphs include data that reflect long-term trends in addition to the most up-to-date information. Therefore, intervals between data points may vary. Data included in some charts have been refined and may differ from the 1992 *State of Kentucky's Environment* report.

The Environmental Quality Commission is grateful to all who provided information, reviewed drafts, and offered expertise during the preparation of this report. The Commission would like to acknowledge and extend its appreciation to Phillip Shepherd, Secretary and Karen Armstrong-Cummings, Deputy Secretary of the Cabinet for Natural Resources and Environmental Protection for their leadership in protecting Kentucky's environment and support for this initiative. EQC extends its thanks to staff in the Cabinet for Natural Resources and Environmental Protection, the Department of Law, the Department of Environmental Protection, the Department of Surface Mining Reclamation and Enforcement, Department for Natural Resources, and the Department of Law, the Nature Preserves Commission, the Petroleum Storage Tank Environmental Assuance Fund Commission, the Department of Agriculture, the Department of Fish and Wildlife Resources, the Kentucky Agricultural Statistics Service, the Kentucky Coal Marketing and Export Council, the Legislative Research Commission, the Kentucky Geological Survey, the Department for Health Services, the Finance and Administration Cabinet, the Kentucky Infrastructure Authority, the Kentucky Public Service Commission, the Department of Mines and Minerals, the Office of the Attorney General, the Department of Local Government, State Data Center, Economic Development Cabinet, the University of Kentucky Departments of Agriculture, Geography, and Forestry, the U.S. Environmental Protection Agency, the U.S. Office of Surface Mining, the U.S. Geological Survey, the U.S. Department of Agriculture Soil Conservation Service, the U.S. Forest Service, and other federal, state, and local agencies and universities.

The Commission would also like to thank the members of the *State of Kentucky's Environment* Advisory Committee for assisting with the development and review of this report. Members are: Tony Sholar, KY Chamber of Commerce; Steve Hubbs, Louisville Water Co.; Bill Caylor, KY Coal Assn.; Tom FitzGerald, KY Resources Council; Jim Lee, KY Forest Industry Assn.; Barry Tonning, KY Conservation Comm.; State Representative Rocky Adkins; John Nichols, Associated Industries of KY; Hank Graddy, Sierra Club; Phillip Porter, Logan Aluminium; Liz Natter, KY Governance Project; Laura Knoth, KY Farm Bureau; and Carolyn Embry, American Lung Assn.

The Commission is grateful to The Courier-Journal and photographer Pam Spalding for the photographs used on the cover of this report, and the following individuals and companies who provided information or reviewed portions of the report: Carol Peiffer, KY Utilities; Doug McLaren, Univ. of KY; David Thomas, Osram Sylvania; Greg Bischoff, PCI Inc.; Jay Hill, Ashland Inc.; Anita Netherland, Naval Surface Warfare Ctr.; Darrell May, Alacatel Telecommunications; Kurt Ackerman, Sherwin Williams; Jonathan Miller, E.I. duPont; Donald Hise, Westlake Polymer; Boyce Helms, Air Products & Chemicals; Donald R. Perander, AK Steel Corp.; Ray Dailey, Westvaco Corp.; Terry Strange, DOW Corning Corp; Van Bowersox, Illinois State Water Survey; and Glenn Conners, Western KY University.

A majority of the charts and graphs in this report were prepared by the Environmental Quality Commission using data provided by state agencies and other sources. The Commission welcomes comments, corrections, or additions in order to refine and update information in future publications. Any opinions, findings, or conclusions in this publication are those of the Environmental Quality Commission and do not necessarily reflect the views or policies of the individuals, agencies, or organizations mentioned above.■

Kentucky Environmental Profile 1994

The Kentucky Environmental Profile provides a snapshot of the current status of our environment and natural resources. The profile includes basic population and economic data, as well as information regarding water resources, air quality, waste, toxic pollutants, natural resources, resource extraction, and energy. This profile reflects the progress Kentucky has made in restoring environmental quality.

The following seven chapters of this report afford Kentuckians an opportunity to view how far we have come in reversing the negative trends of pollution. But the job is far from complete. Making Kentucky a cleaner and healthier place to live will require the continued commitment and support of all—citizens, communities, businesses, and government.

Population

Population: 3.68 million[1]
- urban population: 51.8%
- rural population: 48.2%

Number of households: 1.4 million[1]
- households with public sewer: 56%
- households with public drinking water: 80%

Economic

Total employment[2]: 1.97 million

Per capita average income: $16,954

State gross product[3]: $69.8 billion
- by sector: manufacturing (24.6%); wholesale & retail trade (14.8%); services (14.1%); finance/insurance/real estate (13.6%); government (13.3%); transportation/communication/public utilities (9.1%); construction (3.6%); mining (3.4%); farm (2.9%); agriculture services/forestry/fisheries (0.5%)

Tourism revenue: $6.8 billion
- jobs supported by tourism: 143,000

State budget expenditures on environment & natural resource programs: $106.1 million
- percent of total state budget: 0.98%
- per capita environmental expenditures: $28.00

Water Resources

Stream and river miles: 89,461
- miles assessed (monitored and evaluated): 15,891
- assessed waterways polluted: 28%

Sources of stream and river pollution:
- contaminated runoff: 66%
- industrial discharges: 3%
- sewage treatment plants: 24%
- other and unknown: 7%

Miles of waterways with fish consumption advisories: 851

Public lakes: 103
- percent of lakes with pollution problems: 35%

Public drinking water systems: 815
- systems with violations: 48%

Public drinking water violations: 1,346
- percent exceeding drinking water standards: 8.3%
- percent monitoring/reporting violations: 60.5%
- number of boil water notices and advisories: 59

Households dependent on private water wells[1]: 207,000
- percent of Kentuckians dependent of wells: 13.8%
- percent wells tested with bacteria contamination: 47%

Air Quality

Number of ozone pollution exceedences: 7
- counties with ozone pollution problems: 8
- state population living in ozone problem areas: 29%

Carbon monoxide (CO) emissions from vehicles in ozone problem areas and percent of total CO emissions.
- Louisville: 189,542 tons (56%)
- Northern Kentucky: 41,949 tons (70%)
- Ashland area: 18,523 tons (26%)

Industrial emissions of air pollutants:
- nitrogen dioxide[4]: 357,000 tons
- carbon monoxide[4]: 108,000 tons
- volatile organic compounds[4]: 56,000 tons
- airborne particulates[4]: 32,000 tons
- air toxics: 19,300 tons
- ozone depleting chemicals: 1,780 tons
- sulfur dioxide: 853,000 tons
  - percent emitted by power plants: 90%

Hazardous and Solid Wastes

Full quantity hazardous waste generators: 471

Hazardous waste generation: 6.4 million tons
- tons chemically treated: 2,581,611
- tons physically treated: 2,246,116
- tons biologically treated: 276,298
- other treatment: 440,802
- tons incinerated: 10,496
- tons landfilled: 2

Hazardous waste exported out of Kentucky: 162,000 tons

Hazardous waste imported into Kentucky: 124,000 tons

Potential hazardous substance sites: 1,147
- number investigated: 894
- number with contamination: 495
- number cleaned up or under remediation: 318

Underground storage tanks: 37,586
- tanks removed: 15,000
- tank sites with groundwater contamination: 414

Municipal solid waste landfills: 29
- number meeting 1995 liner requirements: 6
- number with groundwater contamination: 13

Municipal solid waste landfilled: 3.75 million tons
- amount disposed from out-of state: 5%

Households participating in garbage collection: 79% (est.)

Open garbage dumps identified: 3,746
- number cleaned up: 1,156

Toxic Pollutants

Generation of industrial toxic chemicals[2]: 155.4 million pounds
- amount recycled or recovered for energy: 45%
- amount released to the environment: 45%
- amount transferred for treatment, disposal: 10%

Releases of 17 priority toxic chemicals[2]: 21 million pounds
- amount of priority toxics reduced since 1988: 33%

Number of toxic spills: 3,164
- average daily number of spills : 8

Natural Resources

Farmland acreage: 14.1 million[5]
- percent prime farmland: 34%
- prime farmland lost since 1987: 6%

Number of farms: 89,000
- percent small family owned: 76%

Farmland in need or erosion control: 5.8 million acres

Farms in need of waste management systems: 3,346

Forestland acreage: 12.7 million
- forestland privately owned: 93%

Forest landowners: 400,000
- landowners with forest management plans: 10%

Number of wood industries: 1,119

Acres annually logged: 140,000 (est.)
- amount of timber processed out of state: 70% (est.)

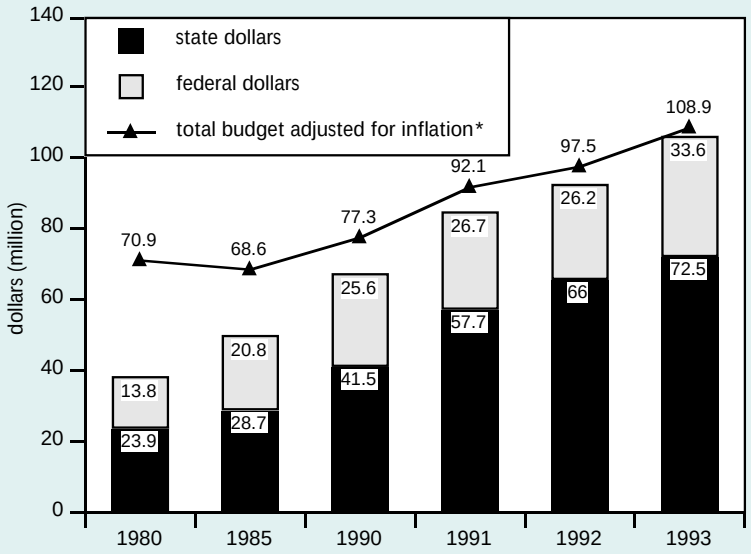
Forestland burned: 17,000 acres
- number caused by arson: 50%
- number caused by open burning: 31%

Wildlife species in Kentucky: 3,863
- percent of U.S. total: 13%
- percent of Kentucky species considered rare: 12%

KY species listed as federally threatened or endangered: 37

Public land managed for wildlife habitat: 156,093 acres
- public land protected for rare species: 28,422 acres

State Budgeted Expenditures on Environmental, Natural Resource, Mining, and Other Related Programs



*Note: Includes general fund budgeted expenditures for the Natural Resources and Environmental Protection Cabinet by fiscal year. *Data adjusted for inflation based on 1994 dollars using the consumer price index generated by the U.S. Bureau of Labor Statistics.*

Source: Natural Resources and Environmental Protection Cabinet, Executive Budget, 1980-93: Finance and Administration Cabinet, Office of Financial Management and Economic Analysis, 1994

Resource Extraction

Coal production: 168.2 million tons
- coal extracted using underground mining: 60%
- coal extracted using surface mining: 40%

Number of coal mines: 696
- percent underground mines: 64%
- percent surface mines: 36%

Mine land disturbed or under reclamation: 263,356 acres
Abandoned mine lands: 100,000 acres (est.)
- acres reclaimed: 18,330

Crude oil production: 4.6 million barrels
- number of active wells: 23,522

Natural gas production: 87 trillion cubic feet
- number of active wells: 12,836

Abandoned oil and gas wells: 33,011
- number plugged by state: 772

Oil field pits tested with radioactive contamination[6]: 23%

Energy

Total statewide energy consumption[2]: 1,044 trillion Btu
Energy consumption by sector[2]:
- industrial: 40%
- transportation: 37%
- residential: 14%
- commercial: 9%

Residential, commercial, and industrial energy sources[2]:
- electricity: 35%
- natural gas: 28%
- petroleum: 25%
- coal: 12%

Per capita personal vehicle miles traveled: 10,451 miles
- per capita gas consumption: 442 gallons
- average vehicle miles per gallon of gas: 23

How Kentuckians travel to work[1]:
- drive alone: 78%
- carpool: 15%
- walk: 3.5%
- work at home: 3%
- public transportation: 1.5%

Enforcement

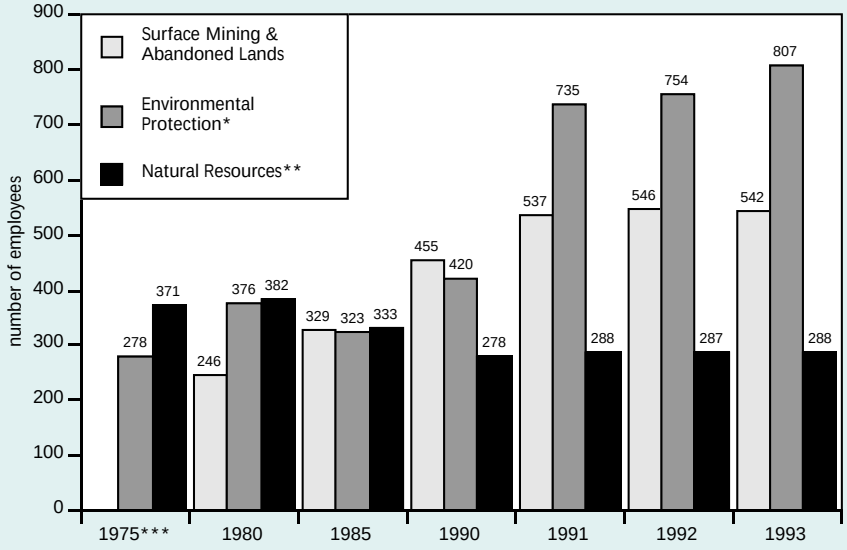
KY Natural Resources and Environmental Protection Cabinet legal cases: 6,319
- coal mining cases: 5,596
- air, water, waste, natural resource cases: 733

Water, waste, air, and coal mining penalties assessed by final order of the Secretary:
- 1991: $2,103,980
- 1992: $4,174,471
- 1993: $5,447,860

Environmental criminal convictions[7]: 5

[1]1990 census data. [2]1992 data. [3]1991 data. [4]Excludes Jefferson County due to unavailability of data. [5]Includes 3.2 million acres of inactive farmland. [6]Tests conducted in Lawrence and Johnson counties. [7]Includes convictions prosecuted at the federal, state, and local level. Note: Profile data for 1993 or 1994 unless otherwise noted.

State Surface Mining, Environmental, and Natural Resource Program Staffing Trends



*Note: Data by fiscal year. *Includes air, water, waste and lab. **Includes conservation, forestry, energy. ***175 staff for natural resources and surface mining combined for a total of 371 in 1975.*
Source: Natural Resources and Environmental Protection Cabinet, Executive Budgets 1975-1994

Chapter 1

Water Resources

Water Resources

Evaluating the progress Kentucky has made in protecting its water resources is the focus of this chapter. Environmental indicators, measuring stream, river, lake, and groundwater conditions, provide an overall picture of water quality. New indicators have been developed to better evaluate the quality of public drinking water in Kentucky.

Other water resource issues, such as floodplain protection and dam safety, are reviewed in the water quantity section of this chapter. And lastly, state water enforcement measures are included to provide a general record of the regulated community's compliance with water quality rules and standards.

I. Stream, River, and Lake Water Quality

Overall, water quality in streams and rivers continues to improve, according to the indicators presented in this chapter. The percentage of monitored and evaluated stream and river miles impacted by pollution is less than it was two years ago. Stepped-up enforcement of water quality rules and improved compliance are among the measures attributed to these improvements.

Pollution Sources. Contaminated runoff from farms, coal mines*, and urban areas collectively poses the most widespread and elusive water pollution problem in the state. While efforts to control soil erosion have led to water quality improvements, contaminated runoff remains the greatest source of water pollution in the state.

Bacteria from improperly treated human and animal waste continues to be a major pollution problem as well. High levels of bacteria have made many waterways unfit for swimming. Discharges from small, poorly operated sewage treatment plants, and runoff from livestock farms contribute to the bacteria problem as do malfunctioning septic tanks and illegal straight pipe discharges to streams.

The full extent of pollution caused by illegal straight pipe discharges to streams is unknown. However, a 1993 stream bank survey along tributaries of the North Fork of the Kentucky River in Letcher County discovered 1,025 illegal straight pipes from homes and businesses of which an estimated 25% were discharging sewage. Hundreds of combined stormwater sewer pipes in older cities, which can overflow during wet weather, also contribute to bacteria problems in urban watersheds.

Toxic Chemicals. The amount of toxic chemicals reported released to streams and rivers in Kentucky de-

Highlights

Stream, River, and Lake Water Quality

- Water quality continues to improve across the state. Data reveal that 72% of the 15,891 miles of stream and rivers assessed are meeting standards designed to protect aquatic life, swimming, and public water supply uses.
- Contaminated runoff from farms, coal mines*, and urban areas is the greatest source of water pollution in Kentucky.
- Bacteria from human and animal waste and siltation remain the two leading water pollution problems in the state.
- The amount of toxic chemicals reported released by industries to waterways in 1992 declined 20% compared to 1991. However, toxic chemicals in fish tissue have led to the recent posting of two additional fish consumption advisories and now include 859 miles of streams and rivers, one lake, and five ponds in the state.
- Sixty-five percent of the 103 public lakes monitored fully support swimming, fishing, and drinking water uses. Contaminated runoff from farmlands is the greatest source of pollution to those 36 lakes with water quality problems.

Drinking Water

- About three million Kentuckians have access to public drinking water. Twenty percent of the population rely on private wells, springs, and cisterns.
- Drinking water violations at 815 public systems have increased by almost 50% since 1991. About 90% of 1,346 violations in 1993 were monitoring and reporting infractions.
- In 1993, more Kentuckians were advised to boil their tap water before drinking because of bacterial contamination than ever before, primarily due to water line breaks.
- Incidents of groundwater pollution from waste sites and other sources continue to mount. Contamination was detected in 47% of the 1,885 private water wells tested for bacteria in 1993.

**Water pollution from abandoned and active coal mines combined in 1994 Kentucky Report to Congress on Water Quality.*

clined 20% between 1991 and 1992 as a result of industry efforts to curb the use and generation of some of these substances. Several companies have also reduced the amount of toxic chemicals they discharge to municipal wastewater treatment plants. For example, Armour Foods in Springfield recently eliminated 70,000 pounds of toxic chemicals discharged to a publicly owned wastewater treatment plant by switching from sulfuric acid to carbon dioxide to adjust the pH in the plant's effluent.

Testing of fish tissue for toxic chemicals at various stream locations reveals most samples had levels well within the standards set to protect public health. But some of these tests continue to reveal problems. Fish consumption advisories remain in effect along 664 miles of the Ohio River bordering Kentucky. Another 195 miles of rivers and streams in the state are posted as unsafe for fishing due to high levels of toxic chemicals found in fish tissue. In 1993, five ponds, and in 1994, the Green River Lake, were added to the consumption advisory list after unsafe levels of toxic chemicals were discovered in fish.

Lakes. Little overall progress can be seen during the past two years in reducing the percentage of public lakes impacted by pollution. Contaminated runoff from farmland is the major source of water pollution in lakes. Many of the 36 impaired public lakes have nutrient problems which contribute to unhealthy fish populations.

II. Groundwater

The 1992 *State of Kentucky's Environment* report revealed that little was known about the quality of the state's groundwater resources. Since then, additional instances of groundwater contamination have been detected, but little progress has been made in determining the overall quality of this resource statewide.

Groundwater Contamination. An estimated 207,000 Kentucky households depend on private wells for drinking water, according to the 1990 Census. The quality of water from these wells for drinking is generally unknown since they are not required to be tested, except at the time they are drilled, and then only for bacteria. Well owners can have their water supplies tested for bacteria by the Department for Health Service. Tests conducted by the department found that 46% of the 1,885 private wells sampled in 1993 were polluted by bacteria.

A survey of water wells conducted during the past few years by the University of Kentucky, the Kentucky Geological Survey, and others, detected various levels of agricultural chemicals—including nitrates, nitrites, alachlor, and triazine—in the 4,859 private water wells tested. However, only a small percentage of the wells sampled exceeded levels set to protect public health for these chemicals.

Hundreds of leaking underground storage tanks and hazardous waste sites have also degraded groundwater resources. Monitoring at 13 of the state's 29 active municipal solid waste landfills has detected groundwater pollution problems.

Pollution Prevention. The state enacted regulations in 1994 to require the development of plans to prevent

Kentucky River Basins

Source: University of Kentucky, Department of Geography

groundwater contamination from industrial and other pollution sources. A separate measure was also passed by the state legislature in 1994 creating the Agriculture Water Quality Authority to promote environmentally sound agricultural practices and to assist farmers prepare plans to prevent water pollution. These efforts should help to protect groundwater quality. However, determining the effectiveness of protection programs will be difficult until an ongoing monitoring program that evaluates the condition of groundwater (similar to that conducted at streams, rivers, and lakes) is instituted.

III. Public Drinking Water

There is no doubt that the quality of Kentucky's public drinking water has improved since the enactment of the federal Safe Drinking Water Act in 1974. An estimated three million Kentuckians now have access to drinking water treated by public systems, according to census data.

Quality and Threats. Many of the state's 815 public drinking water systems draw their supplies from surface sources such as streams, rivers, lakes, or reservoirs. About one-fourth of the public drinking water systems rely on groundwater.

A little less than half of the 815 public drinking water systems operating in Kentucky violated drinking water rules in 1993, an increase since 1991 and 1992. Most of these violations (71%) occurred at the 377 smaller public systems that serve 500 people or less. About 90% of the 1,346 drinking water violations cited in 1993 were monitoring and reporting infractions.

Community public drinking water systems are required to monitor and treat drinking water for 85 contaminants. Violations of drinking water standards, known as Maximum Contaminant Levels (MCLs), for bacteria continue to decline. But problems with organic chemicals in drinking water remain. The presence of toxic chemicals in drinking water is considered by the U.S. Environmental Protection Agency (EPA) to be one the greatest environmental threats in the nation.

Eight consumer advisories were issued by the state in the past two years due to problems at public drinking water systems. The advisories cautioned people in affected areas not to drink tap water due to the presence of unsafe levels of chemicals. A new round of testing for 58 regulated and nine unregulated chemicals is currently underway to assess the extent of these chemicals in public drinking water.

Another threat to drinking water is a group of organic chemicals called trihalomethanes (THMs). These suspected human carcinogens are produced as a chemical by-product of chlorine used to disinfect drinking water. Most of the 129 public drinking water systems monitoring for THMs in Kentucky currently meet the standards. In 1993, the state cited 23 violations of the THM standards, compared to 39 in 1992. The U.S. EPA is considering a more stringent standard for THMs as part of a continuing program to reduce the risk from disinfection by-products in drinking water. These risks are being weighed in conjunction with the benefits provided by disinfection.

In recent years, public drinking water has also been impacted by turbidity problems. Turbidity violations at drinking water systems in Kentucky increased from 14 in 1992 to 62 in 1993. Turbidity, caused by small particles of silt, clay, or other matter, can interfere with the water disinfection process and allow pathogens to survive.

The deadly waterborne disease outbreak that occurred in Milwaukee during 1993 was most likely caused by a failure in the treatment process, indicated by elevated turbidity levels in treated water. This failure allowed the parasite *Cryptosporidium* (crypto), commonly found in animal waste, to pass through the treatment system. Contaminated tap water from the system caused the hospitalization of 4,000 people, 100 of which died, according to city health officials.

It is not known how extensive a problem crypto is in Kentucky or other states since monitoring drinking water for the parasite is not currently required. Eight public water systems in Kentucky have voluntarily tested their raw (untreated) water supply for crypto and detected it in some samples. However, there has been no reported instance of illness related to the parasite in Kentucky. The U.S. EPA is considering requiring routine testing for crypto at systems serving 10,000 people or more. However, many drinking water providers consider proper and improved operation of water treatment plants to be the best approach to reducing the risks associated with crypto.

Boil Water Notices. Many more Kentuckians were advised to boil their water in 1993 compared to any previous year. Boil water notices or advisories are issued when there is bacterial contamination or the potential for contamination of public drinking water supplies. Waterline breaks, which allow the infiltration of contaminants, are responsible for many of the 56 boil water notices and advisories issued in 1993.

IV. Water Quantity

The state is fortunate to have abundant supplies of water. However, the variable distribution of water has led to shortages in several communities in the past. Twenty-seven communities continue to be designated as vulnerable to droughts.

State law requires each county, in partnership with municipalities and water suppliers, to prepare a long-range water supply plan by 1998. To date, 102 counties are developing plans to assess future water needs and available emergency supplies. In Eastern Kentucky, many communities are discovering that current supplies cannot support future needs and alternatives, such as the use of

underground coal mine shafts as reservoirs, are being studied. The construction of a controversial $50 million, 55-mile pipeline to the Ohio River to supplement Fayette and surrounding counties water supply has also been proposed by the Kentucky American Water Company.

In some cases, water shortages are the result of inadequate treatment capacity. As economic and residential growth occurs more systems are facing water treatment capacity limitations. Fifteen public water systems in ten counties are currently under "tap-on" bans for additional service connections due to inadequate water treatment capacity or compliance problems.

In general, most communities and water utilities have not emphasized water conservation because of adequate supplies. But recently, the Public Service Commission (PSC), a state government agency that regulates rates of various privately-owned utilities, has increased its efforts to promote water conservation as an alternative to expansion and increase in rates requested by some water companies. In some cases, the PSC devised rate schedules that discourage excessive water use in homes and businesses.

Floodplain Management. Extensive flooding occurred in the Commonwealth during 1993 and 1994. The Division of Water has a floodplain management program that issues about 600 stream construction permits and approvals a year. However, state government cannot continuously monitor every mile of stream in the Commonwealth and must rely on local floodplain ordinances to minimize flood damage to property and reduce risk to public safety. But one-third of the 255 communities designated as vulnerable to flooding have yet to adopt a floodplain protection ordinance.

Dam Safety. Seven percent of the 908 dams on the state inventory are considered unsafe. The state responded to only one dam emergency during the past two years.

V. Water Enforcement Measures

Compliance with environmental rules can provide another measure of environmental quality. The Division of Water has increased its ability to enforce regulations during the past few years as more inspectors have been hired—from 58 in 1990, to 79 in 1993. As a result, the number of violations of water rules and the amount of penalties collected reached record levels in fiscal year 1992-93. The number of violations has since declined.

Targeted Enforcement. The Division of Water has begun targeting its enforcement actions in some watersheds to better address pollution problems. One example is the North Fork of the Kentucky River. High levels of bacteria led to swimming advisories along 163 miles of the river for the past four years. An assessment of the problem found that 43% of the sewage treatment plants in the watershed were violating water quality standards. A targeted enforcement strategy, focusing on problem plants, reduced the number of violators to 11% in 1994. As a result, the swimming advisory was lifted along 76 miles of the river.

The state is also making some headway in reducing chloride pollution from oil and gas drilling operations. Levels of this pollutant have declined at 19 stream monitoring stations. The reductions are attributed to stronger enforcement of water quality rules at the 23,500 oil and 12,836 natural gas wells operating in the state, better industry compliance, and declining oil production.

Public Education and Involvement. A public opinion poll conducted by the University of Kentucky in 1994 revealed that water quality remains one of the greatest environmental concerns in Kentucky. Each year, the Division of Water responds to thousands of citizen complaints regarding water pollution.

Growing public awareness and commitment to restoring Kentucky's waterways have led to action at the local level. A number of citizen groups, such as Rockcastle River Rebirth, Elkhorn Trust, and the Beargrass Creek Task Force have formed to address local water pollution problems. Numerous local streamside cleanups take place each year throughout the state. More than 300 streams, 35 lakes, 30 wetlands, and 9 karst or underground systems have been adopted and are monitored by 345 Water Watch groups.

Watershed Protection. Several communities have initiated watershed management strategies during the past few years to protect local waterways. Through the Community Stream and River Grant Program, a state program established in 1990 to promote partnerships to improve water resources, a number of innovative and effective projects have been undertaken. Among these are:

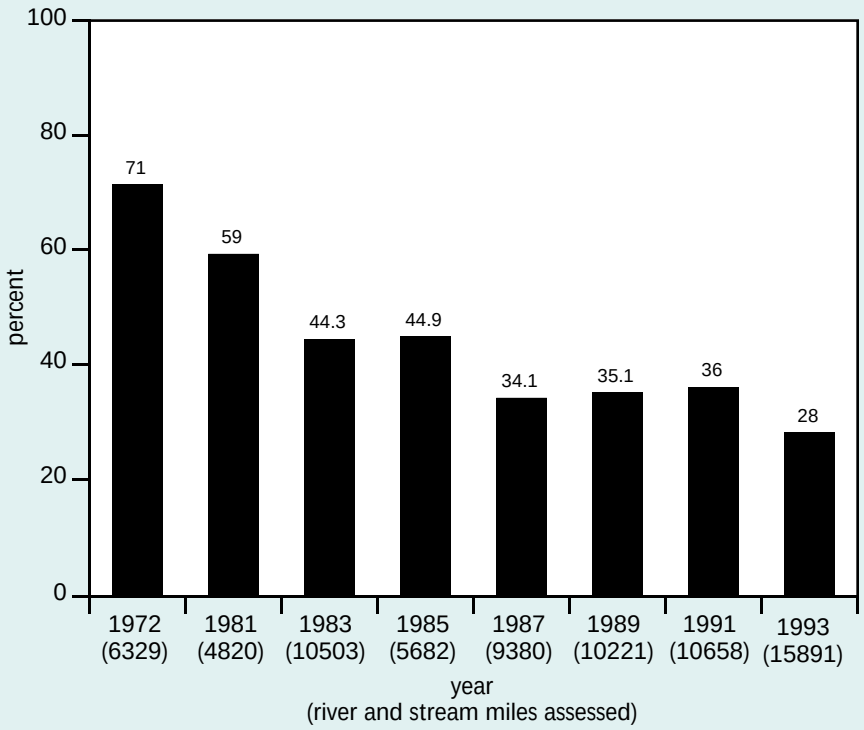
- enhancement of the Russell Fork of Big Sandy River by Elkhorn City, Pikeville, Pike County, and the Pike County Chamber of Commerce and Tourism Commission;
- a management plan for the North Fork of the Little River by the City of Hopkinsville, Christian County, Pennyrile Resource Conservation and Development Council, and Pride Inc;
- development of an environmental education program for Lost River Valley and Cave by the City of Bowling Green, Warren County, and Friends of Lost River and;
- a strategic development plan for the Rockcastle River by Rockcastle, Jackson, and Laurel counties, and the Cumberland Valley Area Development District.

Watershed protection was the also the focus of a task force assembled by Jefferson County in 1993. The task force, composed of government, environmental, and industry representatives, has proposed a regional multi-county/agency organization be established to help clean up the watershed.■

I. Stream, River, and Lake Water Quality Indicators

Figure 1

Percentage of Streams and Rivers Impaired by Pollution in Kentucky

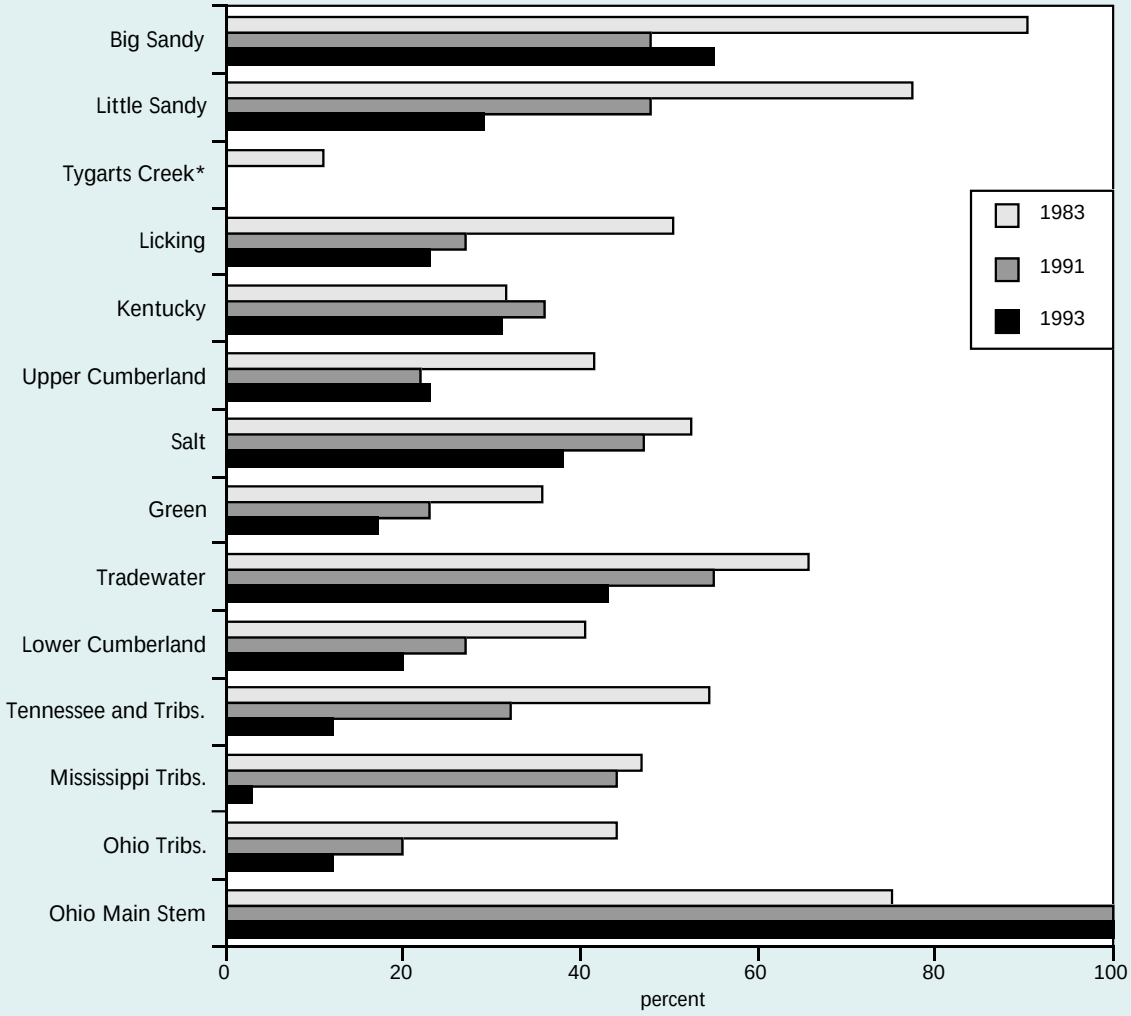


Note: Based on stream miles assessed (evaluated and monitored) not supporting or partially supporting designated uses due to human-caused pollution. Includes Ohio River assessment for all years as provided in Ohio River Valley Water Sanitation Commission 305b reports.
Source: Kentucky Division of Water, Kentucky Reports to Congress on Water Quality, 1972-94

Data from 44 state-operated water monitoring stations located throughout the Commonwealth, combined with information from biological surveys, provide a general indicator of water quality in Kentucky. Data reveal the percentage of assessed stream and river miles impaired by human-caused pollution continues to decline as a result of control efforts. In 1993, 72% of the miles of waterways monitored in the state could be fully used for swimming, fishing, and as a drinking water source compared to 64% in 1991.

Figure 2

Percentage of Assessed Stream and River Miles in Kentucky Impaired by Pollution, by River Basin



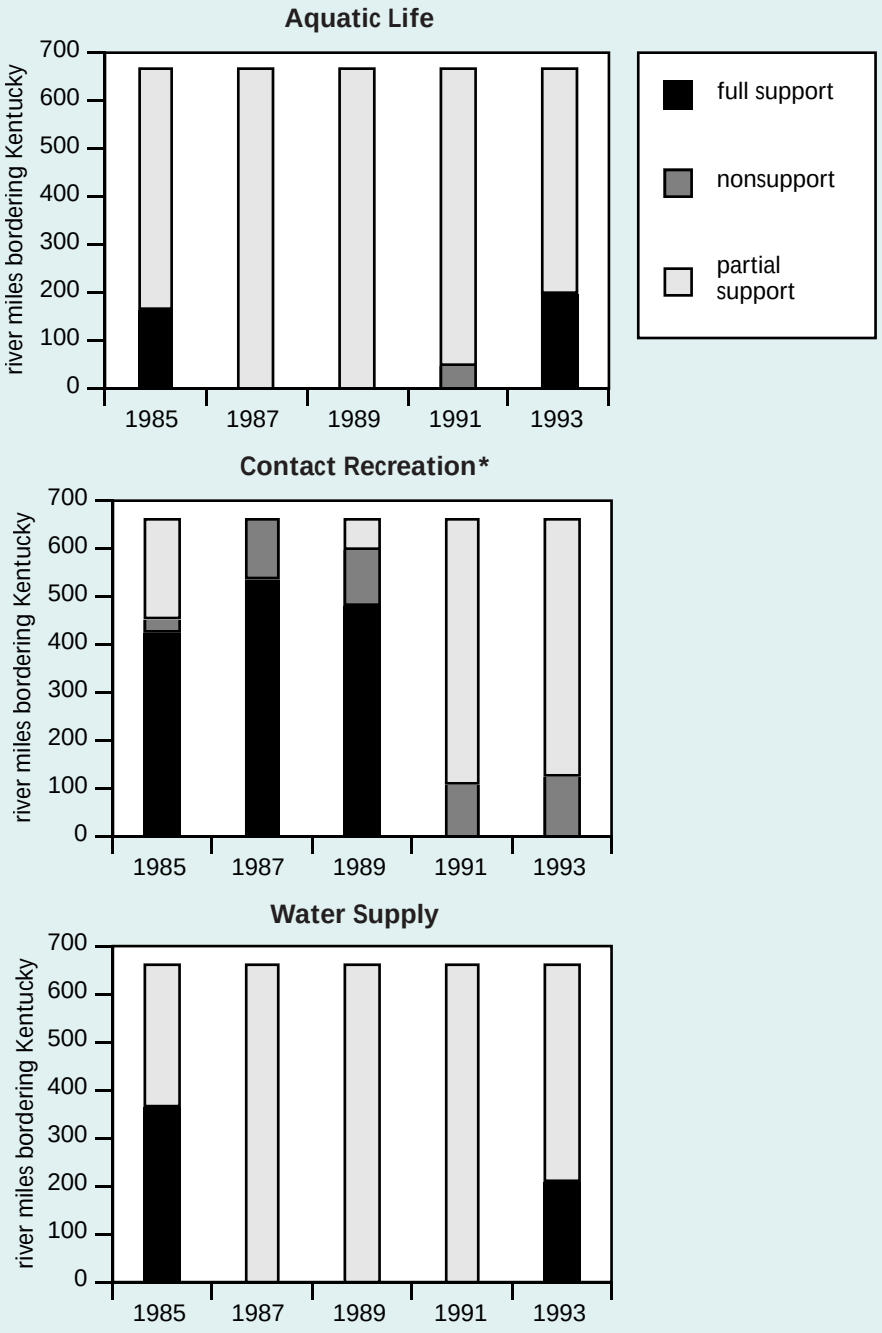
*Note: Based on stream miles assessed (monitored and evaluated) not supporting or partially supporting designated uses due to human-caused pollution. *Monitoring of 194.9 miles of Tygarts Creek in 1991 and 1992 revealed that all miles supported their designated uses.*

Source: Kentucky Division of Water, Kentucky Reports to Congress on Water Quality, 1984, 1992, 1994

Water quality problems differ by river basin due to varying land uses, physical environments, and pollution sources. A review of stream and river analyses conducted by the Division of Water reveals that, since 1983, the percentage of assessed river miles impaired by pollution continues to decline in all river basins with the exception of the Ohio due to the fish consumption advisory issued for the entire length of the river bordering Kentucky in 1989. Over the short-term (1991 to 1993), the percentage of stream and river miles impacted by pollution increased in the Big Sandy and Upper Cumberland basins. In those basins, additional monitoring revealed problems associated with coal mining and improperly treated sewage. With 89,431 miles of rivers and streams in Kentucky, more attention is being placed on assessing water pollution by river basin and watershed in order to target and address problems more effectively.

Figure 3

Ohio River Water Quality Trends Along the Kentucky Border



*Note: Based on 663.9 miles of Ohio River bordering Kentucky fully supporting (all uses supporting), partially supporting (one or more uses partially supporting), or not supporting (one or more uses are not supporting) uses due to various human-caused pollution problems. *Contact recreation defined as recreational activities where the human body may come in direct contact with water. The increase in miles not supporting and partially supporting contact recreation in 1991 and 1993 is attributed to an increase in water monitoring, according to ORSANCO.*

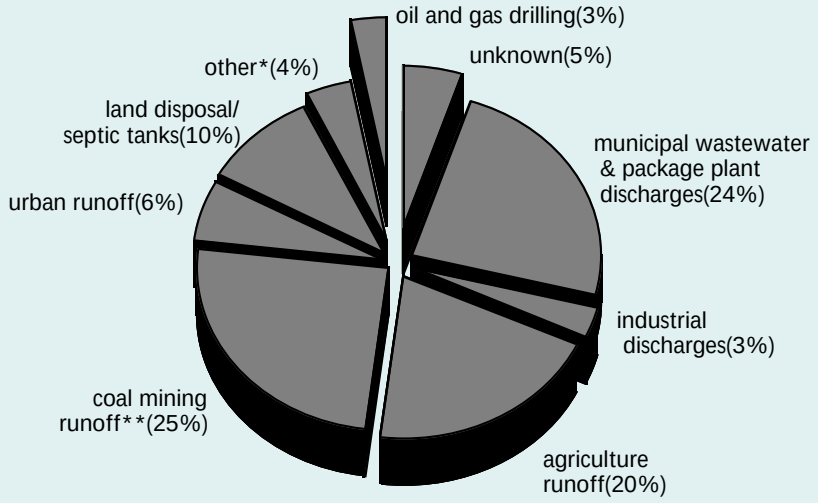
Source: Ohio River Valley Water Sanitation Commission, 1994

The Ohio River has been impacted greatly by pollution. Monitoring of the river has been conducted over the past 46 years by a consortium of eight states known as the Ohio River Valley Water Sanitation Commission (ORSANCO). Monitoring data for the 663.9 mile stretch of the Ohio River bordering Kentucky reveal that water quality has improved in regard to supporting aquatic life, largely because of improved wastewater treatment.

But the Ohio River still does not fully support swimming and other contact recreation. This is due to high bacteria levels primarily attributed to combined stormwater and sewer pipe overflows, which typically occur in older cities during wet weather. To date, 358 combined sewer overflow points have been identified in 26 cities in Kentucky.

The Ohio River also serves as a source of drinking water to three million people, many of whom live in Kentucky. The quality of the river for use as a water supply has improved somewhat since 1991. However, an extensive monitoring program by the Louisville Water Company has indicated the presence of Atrazine, an agricultural herbicide, in Ohio River water. The company currently treats its water to meet the public drinking water standard for this chemical.

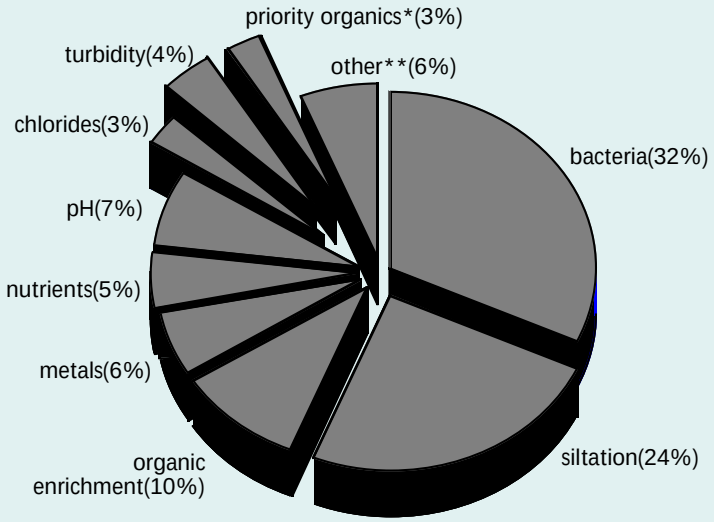
Figure 4
Sources of River and Stream Pollution in Kentucky (1992-93)



*Note: Based on miles of streams and rivers not supporting or partially supporting uses in 1992-93 due to human-caused pollution. Many waterways have multiple sources of pollution which are reflected in this chart *Other includes logging, construction, and stream modification. **Water pollution problems from abandoned and active mine sites combined (not distinctly separated in 1994 Report to Congress on Water Quality).*
Source: Kentucky Division of Water, 1994 Kentucky Report to Congress on Water Quality

Contaminated runoff from coal mines, landfills, farms, urban areas, and other sources collectively contribute 66% of the known water pollution problems in the state. Improperly treated sewage from wastewater plants also remains a major source of water pollution in the state.

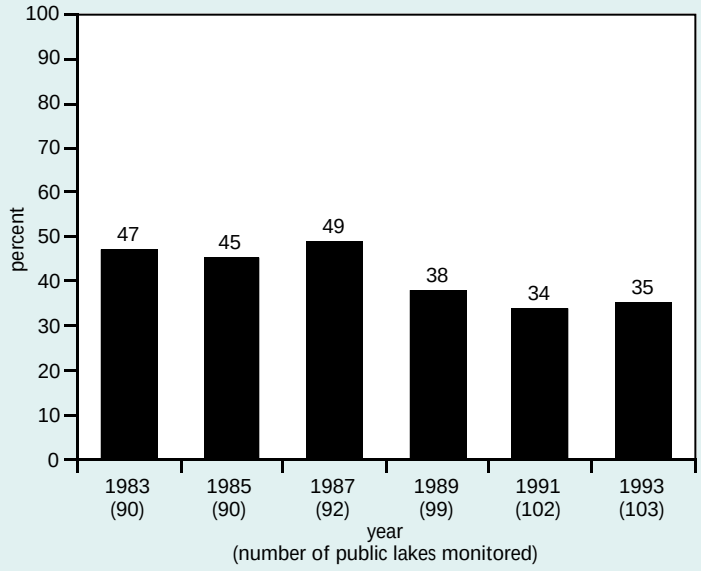
Figure 5
Causes of Stream and River Pollution in Kentucky (1992-93)



*Note: Based on miles of streams and rivers not meeting or partially meeting designated uses in 1992-93 due to human-caused pollution. Many waterways have multiple causes of pollution which are reflected in this chart. *Priority organics include 126 chemicals and metals designated by the U.S. EPA as being highly toxic. **Other includes suspended solids (2%), habitat alteration (2%), unknown toxicity (1%), oil and grease (1%).*
Source: Kentucky Division of Water, 1994 Kentucky Report to Congress on Water Quality

The leading cause of water pollution in Kentucky is bacteria. High levels of bacteria from animal and human waste resulted in the swimming advisory currently in effect along 86 miles of the North Fork of the Kentucky River. The Division of Water has also generally recommended that human contact with waterways below urban areas be avoided, particularly after a heavy rainfall, due to high bacteria levels caused by combined stormwater and sewer pipe overflows.

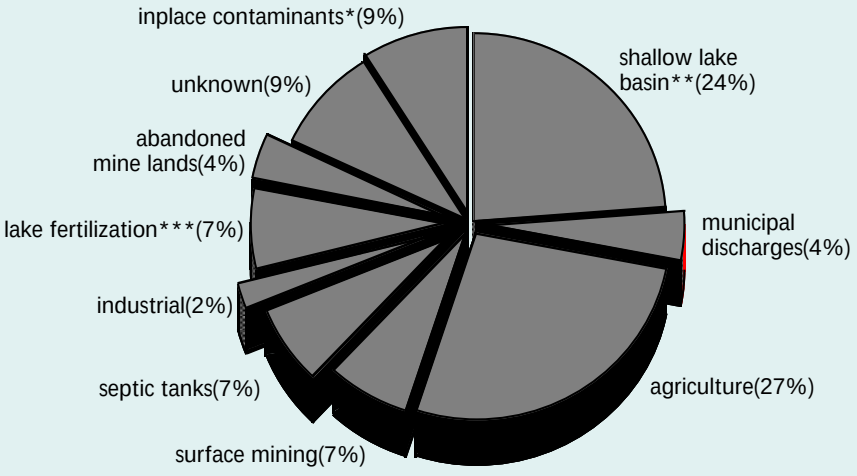
Figure 6
Percentage of Public Lakes in Kentucky Impaired by Pollution



Note: Based on public lakes assessed (monitored and evaluated) not meeting or partially meeting designated uses.
Source: Kentucky Division of Water, Kentucky Reports to Congress on Water Quality, 1982-94

One-third of the 103 public lakes monitored in Kentucky still cannot fully support aquatic life or be used as a water supply source due to pollution problems. The Division of Water continues to address lake pollution problems on a site-by-site basis. Testing of lake fish for toxic chemicals is also underway to identify potential contamination problems.

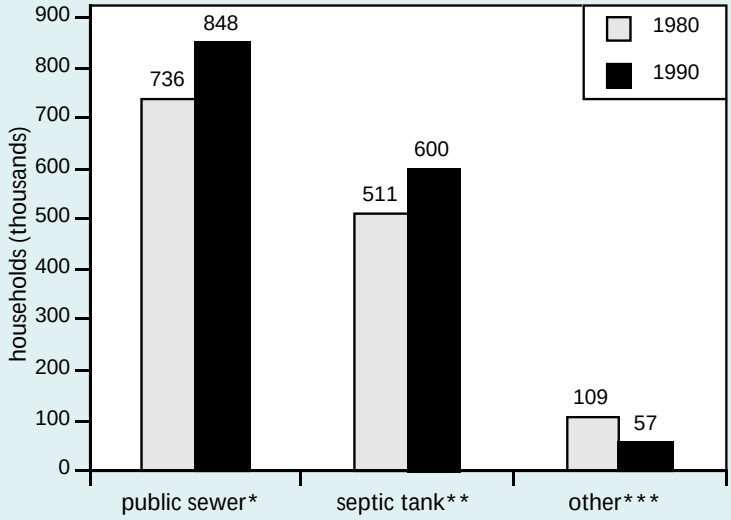
Figure 7
Lake Pollution Sources in Kentucky (1992-93)



*Note: Based on 103 public lakes assessed (monitored and evaluated) not meeting or partially meeting designated uses. Some of the 36 impaired public lakes may have multiple sources of pollution which are reflected in this chart. *Inplace contaminants are chemicals (PCBs, metals) of unknown origin found in lake sediment. **A proliferation of aquatic weeds can occur in lakes with shallow basins hindering recreational swimming and fishing uses. ***Lake fertilization adds additional nutrients to increase fish stocks. Excessive nutrients, however, can cause the proliferation of weeds and affect aquatic and recreational uses.*
Source: Kentucky Division of Water, 1994 Kentucky Report to Congress on Water Quality

The greatest known source of lake pollution in Kentucky is contaminated runoff from farmlands. Rainwater washing over farmland carries topsoil, animal waste, and chemical residues into nearby lakes impacting water quality. Efforts to reduce agricultural runoff have primarily emphasized voluntary soil erosion control practices such as the use of no-till plowing.

Figure 8
Household Sewage Disposal in Kentucky



*Note: Based on occupied and vacant housing units. *Public sewer may be operated by a government body or private organization. **A housing unit is considered to be connected to a septic tank or cesspool when the unit is provided with an underground pit or tank. ***Housing units which dispose of sewage in some other way.*
Source: U.S. Census, Kentucky Data, 1980-90

Fifty-six percent of the households in the state have their sewage piped to wastewater plants for treatment. The remainder rely on septic tanks, seepage pits, and other on-site sewage disposal systems. The Department for Health Services regulates on-site sewage disposal systems and permits, on average, 14,000 systems yearly. They acknowledge, however, that enforcement is difficult and problems with malfunctioning septic systems and illegal straight pipe sewage discharges from homes and businesses to streams exist statewide.

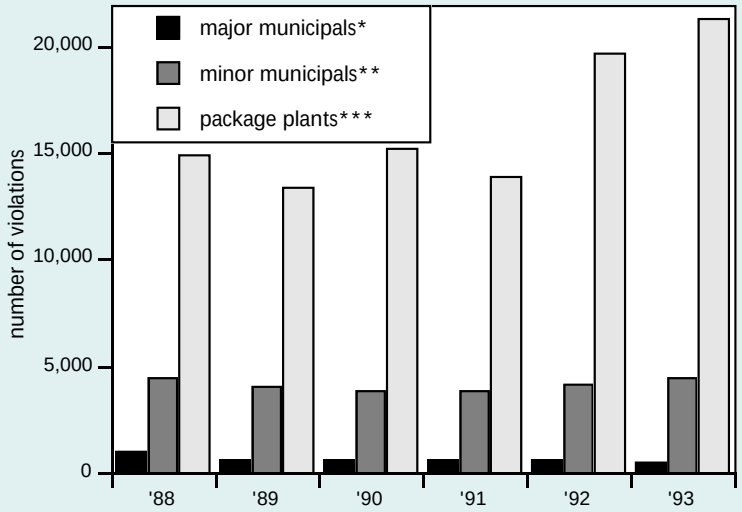
Figure 9
Wastewater Treatment Plants in Kentucky by River Basin

	Municipal Plants		Package Plants*		Industrial Plants**	
River Basin	**1991**	**1994**	**1991**	**1994**	**1991**	**1994**
Big Sandy	15	12	267	268	133	114
Little Sandy	3	3	70	44	10	9
Tygarts Creek	1	1	13	8	9	6
Licking	18	20	140	136	59	53
Kentucky	40	41	301	269	141	135
Cumberland	37	39	222	194	142	111
Salt	24	22	255	203	53	51
Green	38	42	155	124	164	146
Tradewater	4	4	24	22	31	24
Tennessee	9	10	60	38	47	29
Mississippi	12	10	19	17	27	18
Ohio Tributaries	41	39	385	310	181	175
Total	**242**	**243**	**1911**	**1633**	**997**	**871**

**Includes small sewage, subdivision, and school wastewater treatment plants. **Includes major and minor industrial, landfill, and agricultural wastewater treatment plants.*
Source: Kentucky Division of Water, SAS Database, Kentucky Report to Congress on Water Quality, 1991-94

More than 2,700 municipal, package, and industrial wastewater treatment plants are permitted to operate in Kentucky. Discharges from poorly operated and maintained plants, particularly small plants, continue to cause water pollution problems. In 1993, these plants impacted 1,037 miles of monitored waterways in eight river basins and are a particular problem in the Salt, Kentucky, Little Sandy and Cumberland river basins. State and local efforts to merge problem plants and improve operations have reduced the number of package plants by 15% since 1991.

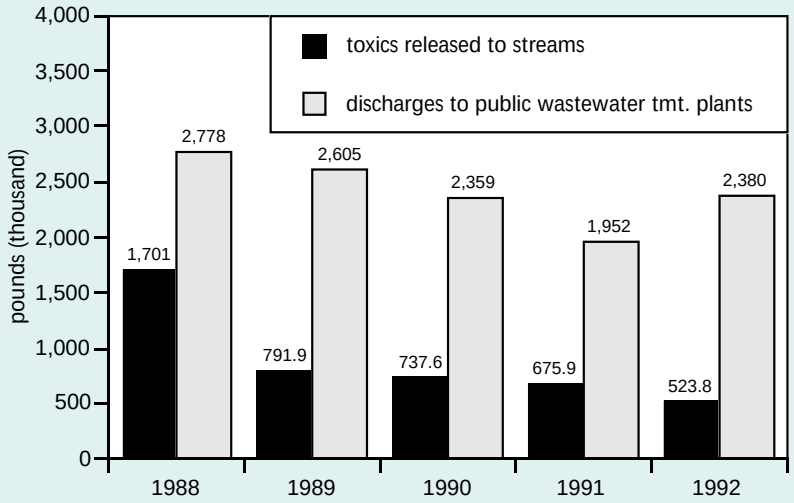
Figure 10
Violations of Permit Requirements at Wastewater Treatment Plants in Kentucky



*Note: By fiscal year. Includes all permit violations. *Major municipal plants designed to treat a million gallons of wastewater a day. **Minor municipal plants designed to treat less than a million gallons of wastewater a day. ***Package plant is a small factory-built wastewater treatment plant that is transported and assembled or set in place at the site.*
Source: Kentucky Division of Water, 1994

Efforts to bring sewage treatment plants into compliance with water quality rules resulted in the citing of a record number of violations in 1993. Many of these violations occurred at small sewage package plants many of which serve subdivisions and schools. Maintaining and upgrading wastewater infrastructure is critical to preventing water pollution problems. An estimated $1.6 billion is still needed to meet immediate wastewater plant needs in Kentucky, according to a 1994 survey of 409 communities by the Division of Water.

Figure 11
Toxic Chemicals Released to Streams or Discharged to Municipal Wastewater Treatment Plants in Kentucky

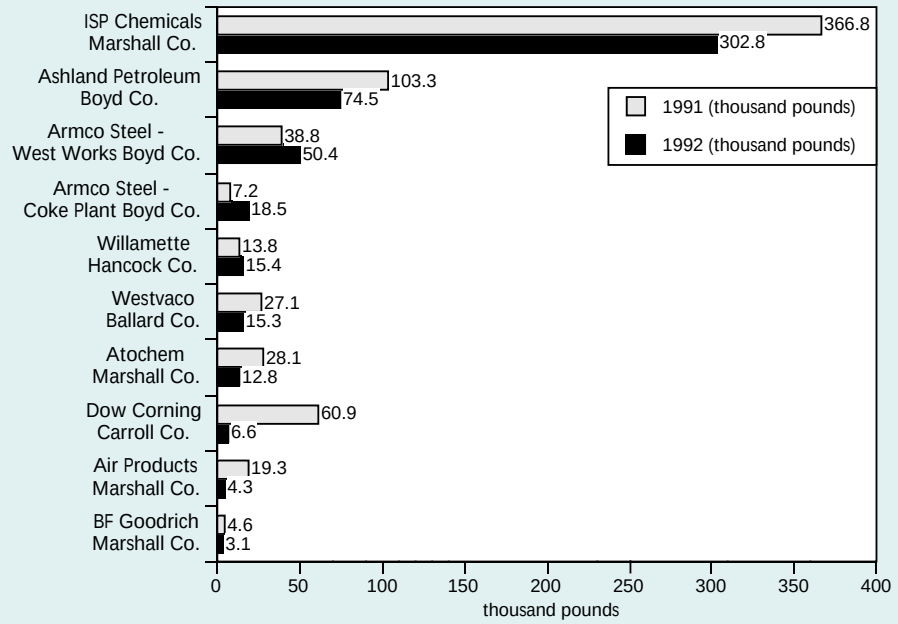


Note: Based on toxic chemical releases and discharges reported by certain manufacturing companies. Does not include all releases such as transportation spills or releases and discharges from facilities not required to report. Delisted chemicals are not included. Data include additional chemicals required to be reported beginning in 1990.
Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92

The amount of toxic chemicals treated and released to streams has declined 70% since industries began reporting in 1988. Toxic releases to streams accounted for less than 1% of the 69.7 million pounds of toxics reported released to the environment in 1992. Industrial discharges of toxic chemicals to publicly owned wastewater treatment plants has varied since 1988.

Figure 12

Top Ten Facilities Reporting Releases of Toxic Chemicals to Streams



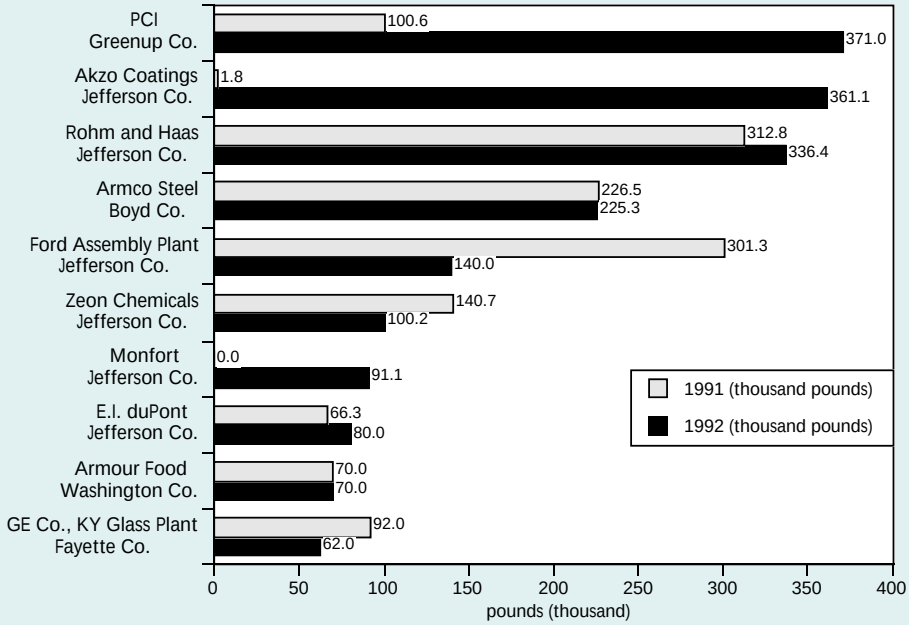
Note: Based on toxic chemicals released to waterways as reported by certain manufacturing companies.

Source: Department for Environmental Protection, Toxic Release Inventory Reports, 1991-92

Ten plants in five counties reported 98% of the industrial toxic chemicals released to streams in 1992. Ammonia, used to make fertilizer, plastics, dyes, and textiles, accounted for 70% of the toxics released to streams. Ammonia is toxic at certain levels but can be effectively treated with advanced wastewater treatment technology.

Figure 13

Top Ten Facilities Discharging Toxic Chemicals to Municipal Wastewater Treatment Plants



Note: Based on toxic chemicals discharged to municipal treatment plants as reported by certain manufacturing companies.

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1991-92

In 1992, 124 companies reported discharges of toxic chemicals to municipal wastewater treatment plants. Ten of those facilities, located in four counties accounted for 79% of the total amount of toxic chemicals discharged to municipal wastewater treatment plants in 1992. These 10 companies are among the 607 industries required to pretreat their wastes to remove toxic chemicals prior to discharge. Pretreatment of toxic chemicals is important since many treatment plants are not equipped to remove these chemicals during the treatment process.

Figure 14

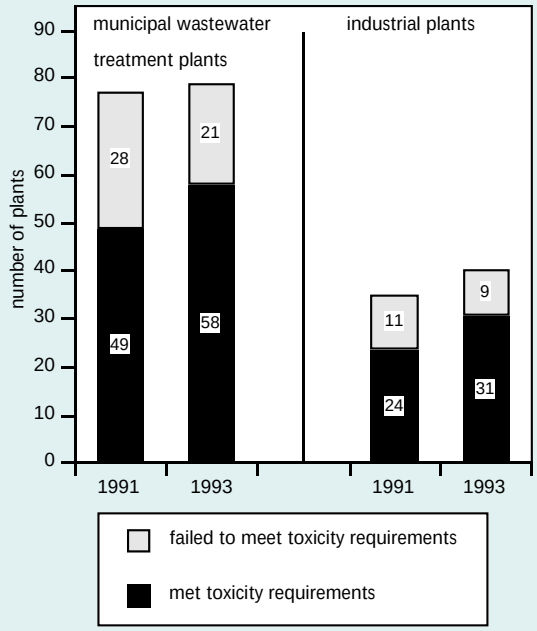
Industrial Wastewater Pretreatment Programs in Significant Noncompliance in Kentucky

Municipal Trmt. Plants*	# Industrial Users	#Users in Significant Noncompliance**
Ashland	7	2
Auburn	1	1
Bardstown	13	1
Bowling Green	19	3
Campbellsville	8	1
Cynthiana	9	2
Elizabethtown	20	4
Franklin	11	1
Glasgow	10	1
Hopkinsville	20	1
Lawrenceburg	6	1
Lexington	53	6
Louisville	121	18
Mayfield	6	3
Mount Sterling	6	2
Paducah	9	1
Russellville	6	1
Stanford	1	1
Winchester	13	2
Total	**339**	**52**

*Note: Significant noncompliance defined as chronic violations of discharge limits, discharges dangerous to public health, or failure to meet compliance schedules and reporting requirements. *Publicly owned municipal wastewater treatment plants. **As of March 1994.*
Source: Kentucky Division of Water, 1994

Industrial wastewater pretreatment programs are effective in treating toxic pollutants only if properly operated and strictly enforced. In March 1994, 52 industries or 9% of the 607 industries pretreating their wastes statewide were in significant noncompliance with permit requirements compared to 21% in 1991. The improvement is attributed to more aggressive enforcement efforts by the Louisville/Jefferson County Metropolitan Sewer District which reduced the number of industries in noncompliance with pretreatment requirements from 71 in 1991 to 18 in 1994.

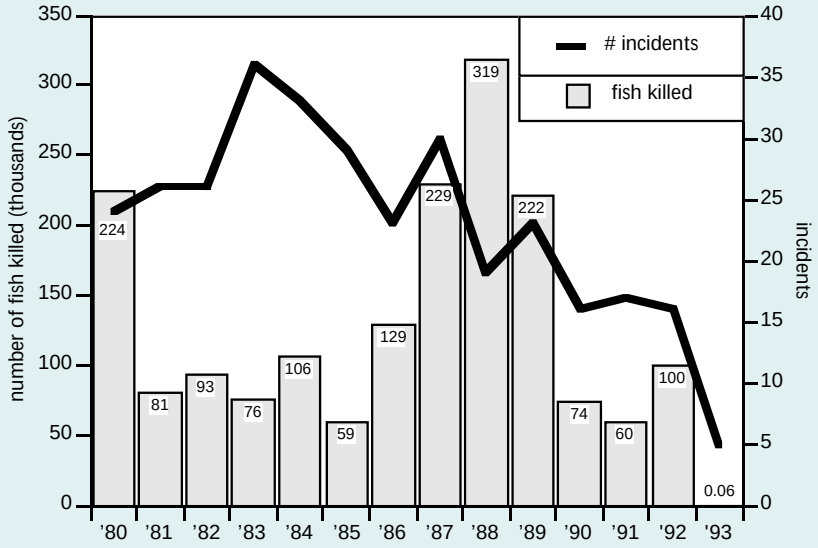
Figure 15
Toxicity Testing at Municipal and Industrial Wastewater Treatment Plants in Kentucky



Note: Based on bioassay or whole effluent toxicity testing, (WET).
Source: Kentucky Division of Water, 1994

Some toxic contaminants can pass through wastewater plants untreated into the receiving stream. Toxicity testing of a plant's discharge can detect the presence of harmful chemicals so additional treatment can be provided. The Division of Water has placed toxicity limits on 79 municipal and 40 industrial wastewater plants to control releases of toxic effluents to waterways. Compliance with toxicity limits is improving at both industrial and municipal plants. However, about one-fourth of these plants still failed to meet toxicity limits in 1993.

Figure 16
Fish Kill Incidents and the Number of Fish Reported Killed in Kentucky

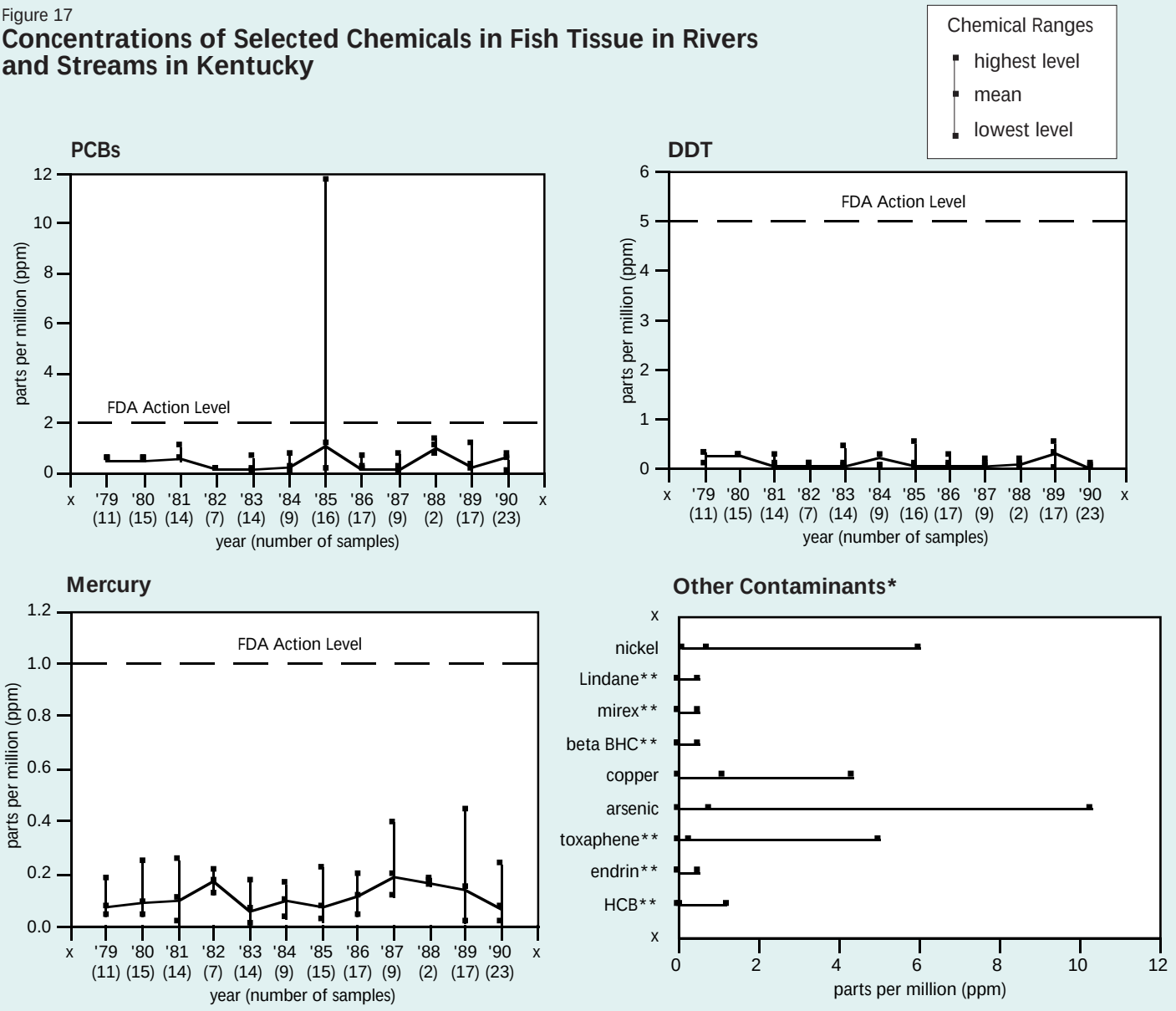


Note: Known fish kills and incidents as reported by the Kentucky Department of Fish and Wildlife Resources to the Kentucky Division of Water.
Source: Kentucky Division of Water, Kentucky Reports to Congress on Water Quality, 1980-94

The number of reported fish kills due to pollution incidents have declined significantly over the past 10 years. The trend is likely the result of improved wastewater treatment and other pollution control efforts. Chemical and oil spills were responsible for the majority (52%) of fish-kill incidents that occurred in 1992 and 1993.

Figure 17

Concentrations of Selected Chemicals in Fish Tissue in Rivers and Streams in Kentucky



*Note: Sampling locations vary. PCBs, DDT, and mercury levels reflect annual average ranges of chemicals for whole-body fish-tissue screening analysis compared to Federal Food and Drug Administration (FDA) action levels for poisonous or deleterious substances in human food and animal feed established to protect human health. FDA action levels based on fish fillets. Test samples based on whole fish analysis. Data for 1990-94 has not yet been entered into the Division of Water database and is therefore unavailable for inclusion in chart. *Based on whole-fish-body analysis and averages for an 11-year period (1979-1990). **Chlorinated pesticides most of which are now banned from use.*

Source: Kentucky Division of Water, 1994

Fish can serve as indicators of stream and river quality. The Division of Water has been monitoring fish tissue for chemicals at various stream and river locations since 1979. The testing assists in identifying contaminants in streams and rivers as well as harmful levels in fish. This chart reflects the highest, mean, and lowest levels of various chemicals detected in fish tissue during each year of testing. Data reveal that most chemical contamination found in fish tissue was below federal action levels set to protect public health. However, federal fish consumption standards have been set for only 14 contaminants. Therefore, assessing the potential health effects of many other chemicals, such as copper and arsenic, detected in fish tissue cannot be determined.

Figure 18
Fish Consumption Advisories Affecting Kentucky

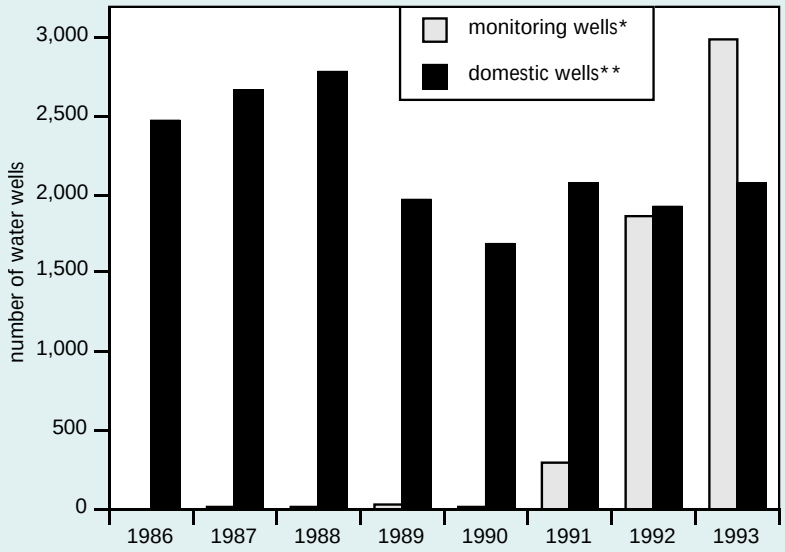
Stream (County)	Pollutants	Source	Miles Covered	Date Posted	Status
Town Branch/Mud River (Logan/Butler/Muhlenburg)	PCBs	Die-casting plant	71.5	Oct. 1985	Cleanup in progress; monitoring continues. All species covered.
West Fork Drakes Creek (Simpson/Warren)	PCBs	Adhesive plant	46.9	April 1985	Monitoring continues; levels in fish appear to be declining. All species covered.
Mississippi River	Chlordane	Urban runoff	71	1986	Reissued in 1994 by state of Missouri for 71 miles bordering KY for carp, sturgeon, and bottom dwellers. Fish tissue levels declining.
Little Bayou Creek (McCracken)	PCBs	Gaseous diffusion plant	6.5	April 1989	On-site cleanup in progress; monitoring continues; fish and surface contamination appears limited to Little Bayou Creek. All species covered.
Ohio River	PCBs Chlordane	Urban runoff	663.9	June 1989	Channel catfish, white bass, carp, paddlefish; monitoring continues; reissued in 1993 for the length of the Ohio River bordering Ky.
W. Ky. Wildlife Mgmt. Area (McCracken)	Mercury	Unknown	5 ponds	Nov. 1993	Largemouth bass. Source of mercury contamination undetermined. Investigation and monitoring continues.
Green River Lake (Taylor/Adair)	PCBs	Gas pipeline	lake	Feb. 1994	Carp and channel catfish. Confined to one small cove. Monitoring continues. Cleanup schedule being finalized.

Source: Kentucky Division of Water; Missouri Department of Health, 1994

Fish tissue testing for various chemicals has led to a number of fish consumption advisories. Advisories are issued when contaminant levels in fish filets exceed the federal FDA standards set to protect public health. Consumption advisories remain in effect along 859 miles of streams and rivers, five ponds, and one lake in Kentucky due to bioaccumulation of toxic chemicals, such as mercury and PCBs, in fish tissue.

II. Groundwater Indicators

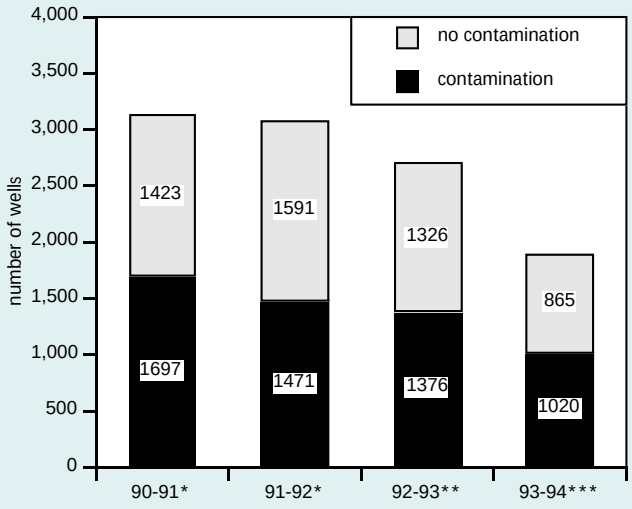
Figure 19
Number of Water Wells Reported Drilled Yearly in Kentucky



*Note: Since 1985 all domestic water wells, and since 1991 all monitoring wells drilled must be reported to the state. *Includes wells drilled to monitor hazardous waste and toxic materials facilities and sites, underground storage tanks, surface mines, site assessment, solid waste facilities, landfarms, and environmental audits. **Includes private drinking water, municipal, livestock, irrigation wells.*
Source: Kentucky Geological Survey Groundwater Repository compiled from Kentucky Division of Water Certified Water Well Drilling Program data, 1986-1994

Little is known about the overall quality of groundwater in the state, even though it is a significant drinking water source. The 1990 census indicates that 207,000 households rely on private drinking groundwater wells. According to state water well records, an average of 2,200 new domestic water wells are drilled each year in the state. The number of wells reported drilled to monitor groundwater for contamination at waste and other sites continues to increase. Nearly 3,000 monitoring wells were drilled in 1993.

Figure 20
Voluntary Testing of Private Drinking Water Wells for Bacteria in Kentucky

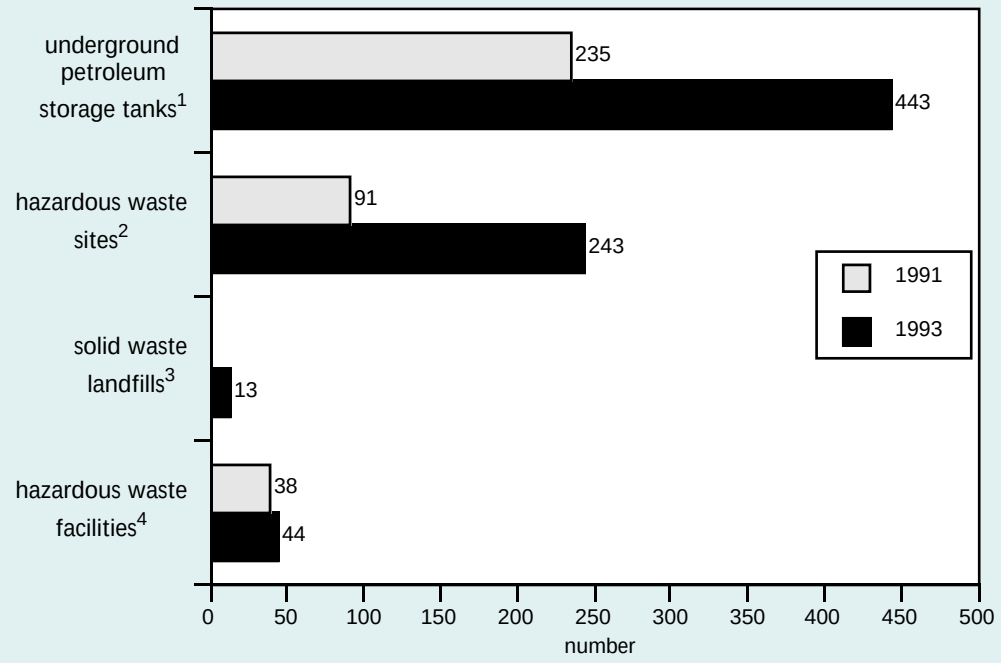


*Note: Data by fiscal year. Water well tests conducted by request for total coliform bacteria. *98 counties reporting. **94 counties reporting. ***92 counties reporting.*
Source: Kentucky Department for Health Services, Local Program Support Branch, 1994

Bacterial contamination from human and animal waste remains the greatest known groundwater pollution problem in the state. The Department for Health Services tests private water wells for bacteria upon request. This testing provides a general indicator of groundwater quality. While the number of water wells tested for bacteria declined in 1993, the percentage of those with contamination has remained fairly constant over the years. During fiscal year 1993-94, tests conducted by 92 counties revealed bacteria problems in 47% of the private drinking water wells sampled.

Figure 21

Groundwater Contamination Incidents at Waste Sites in Kentucky

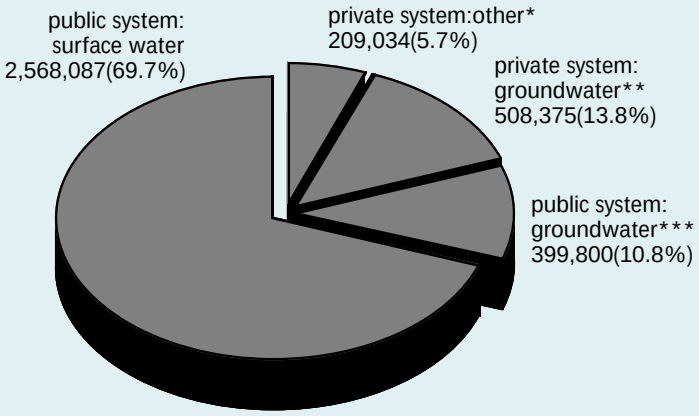


Note: Definition of contamination varies based on the waste site and may include levels exceeding Safe Drinking Water Act Maximum Contaminant Levels (MCLs) or action levels, above background levels for naturally occurring contaminants, or above detection limits for non-naturally occurring regulated contaminants.
[1]Cumulative number of tanks with confirmed groundwater contamination. [2]Cumulative estimated total based on 894 hazardous waste sites investigated. [3]Based on groundwater testing at 29 permitted municipal solid waste landfills currently accepting waste. 1991 data not available. [4]Includes hazardous waste treatment, storage, and disposal (TSD) permitted and non-permitted facilities with on and/or off-site groundwater contamination. In 1993, TSD facilities with groundwater contamination included 13 permitted sites and 31 non-permitted. Non-permitted TSD facilities may include illegal sites or those which do not require permits. There are 91 permitted TSD facilities in Kentucky.
Source: Kentucky Division of Waste Management, 1994

Specific incidents of groundwater contamination are being detected with increasing frequency as more monitoring at waste and other sites is conducted. Contamination has been verified at 443 leaking underground storage tanks, 243 hazardous waste sites, and about half of the state's 29 active municipal solid waste landfills. State agency efforts to consolidate data from groundwater monitoring wells is ongoing to better target problems and assess overall groundwater quality.

III. Public Drinking Water Indicators

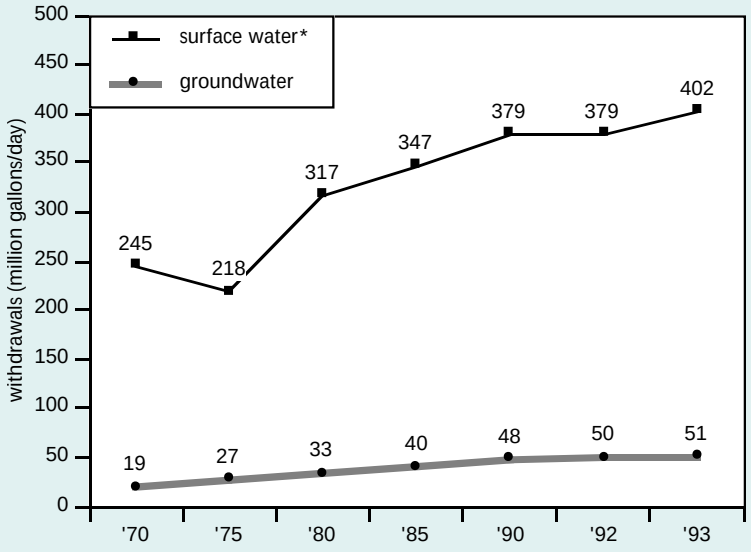
Figure 22
Drinking Water Sources By Population Served in Kentucky



*Note: Based on drinking water sources for 3,685,296 Kentuckians. *Includes cisterns, springs, rivers, creeks. **Includes hand dug or drilled individual wells. ***Includes wells which serve five or more households.*
Source: U.S. Census, 1990; University of Kentucky Center for Business and Economics Research, 1994

Approximately 80% of Kentucky's population, about three million people, now have access to treated public drinking water. The remaining population must rely on private wells, springs, and cisterns for their drinking water supplies.

Figure 23
Public Drinking Water Withdrawals in Kentucky



*Note: Permitted drinking water users that withdraw an average 10,000 gallons per day or more. Based on actual or estimated use. Public drinking water defined as systems serving at least 25 people or having 15 service connections. *Includes springs.*
Source: Kentucky Division of Water, 1994

Nearly three-fourths of the state's 815 public drinking water systems draw their supplies from surface sources such as rivers, streams, lakes, or reservoirs. Underground sources of water, or a combination of underground and surface water, supply the remaining systems. Increased demand, along with the extension of water lines to homes and businesses has almost doubled the amount of water withdrawn for drinking water purposes since 1970. Currently, 102 counties are in the process of developing long-range water supply plans to ensure future supplies.

Figure 24
Public Drinking Water System Violations in Kentucky

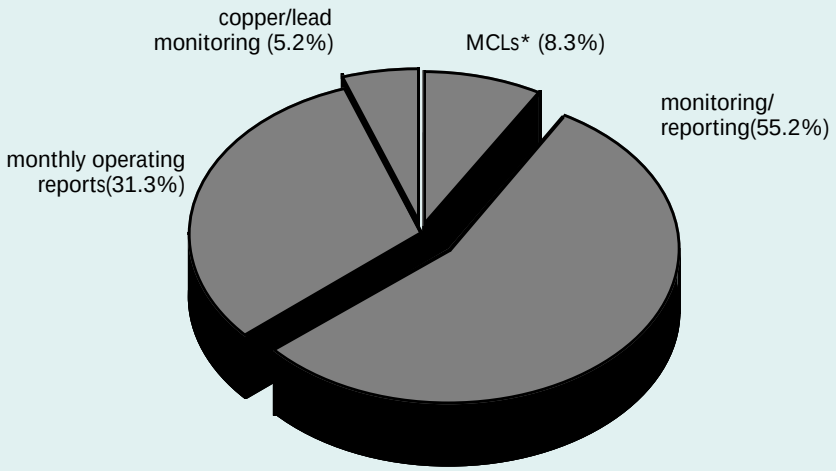
Facility Size (Population Served)	Number of Systems*			Number of Systems with Violations**			Number of Drinking Water Violations** (percent total)		
	1991	1992	1993	1991	1992	1993	1991	1992	1993***
<101	212	205	198	109	92	123	416(47%)	502(30%)	660(49%)
101-500	201	184	179	93	83	83	233(26%)	243(37%)	292(22%)
501-1,000	69	62	60	34	25	19	76(9%)	85 (8%)	77(6%)
1,001-2,500	131	130	122	37	36	51	51(6%)	76(11%)	78(6%)
2,501-3,300	53	55	55	16	18	35	30(3%)	50 (6%)	91(7%)
3,301-5,000	50	47	53	10	11	21	17(2%)	22 (4%)	39(3%
5,001-10,00080	80	81	82	22	23	37	41(2%)	42 (7%)	76(6%)
10,001-50,000	56	60	61	14	14	22	18(2%)	30(5%)	31(2%)
50,001-100,000	4	2	2	1	1	2	1(<1%)	1 (<1%)	2(<1%)
>100,001	3	3	3	0	0	0	0	0	0
Total	**859**	**829**	**815**	**336**	**303**	**393**	**883**	**1,051**	**1,346**

**Includes community systems (serve the same population year round), non-transient non-community systems (serve the same population at least 6 months of the year), and transient non-community systems (serve transient populations). **Includes all violations (calendar year). ***Some Phase II Volatile Organic Chemical testing results included that were not required in previous years.*

Source: Kentucky Division of Water, 1994

The greatest violators of drinking water regulations in Kentucky are those 377 public systems serving 500 people or less. Many smaller systems cannot afford to improve technology or hire full-time personnel. During 1993, an estimated 1.5 million Kentuckians were served by 393 drinking water systems with violations.

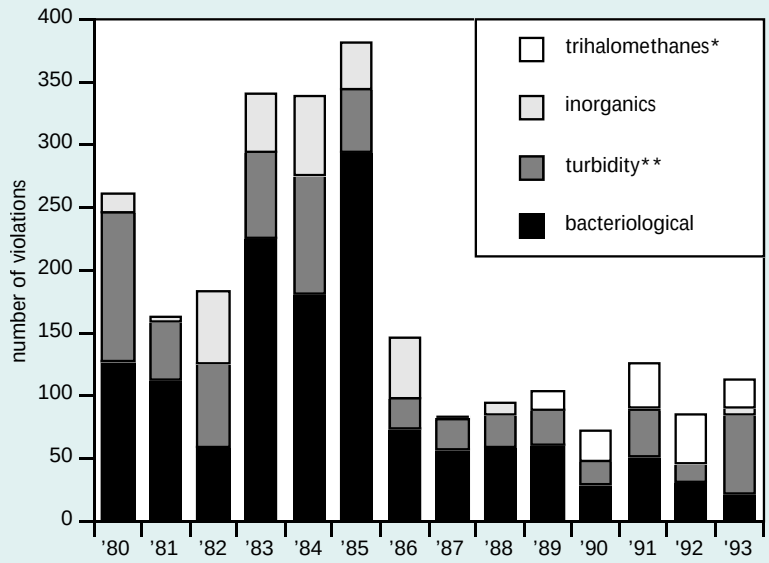
Figure 25
Kentucky Public Drinking Water System Violations (1993)



Note: Based on 1,346 drinking water violations cited by the Kentucky Division of Water in 1993.
**MCLs - Maximum Contaminant Levels - the federal standard set for the maximum amount of a contaminant that is allowed in treated water delivered to a consumer.*
Source: Kentucky Division of Water, 1994

A review of the 1,346 public drinking water violations cited in 1993 reveals that a majority were monitoring and reporting infractions. The failure of a system to monitor for contamination does not necessarily indicate the presence of contamination but can mask an exceedence of a drinking water standard and place consumers at risk.

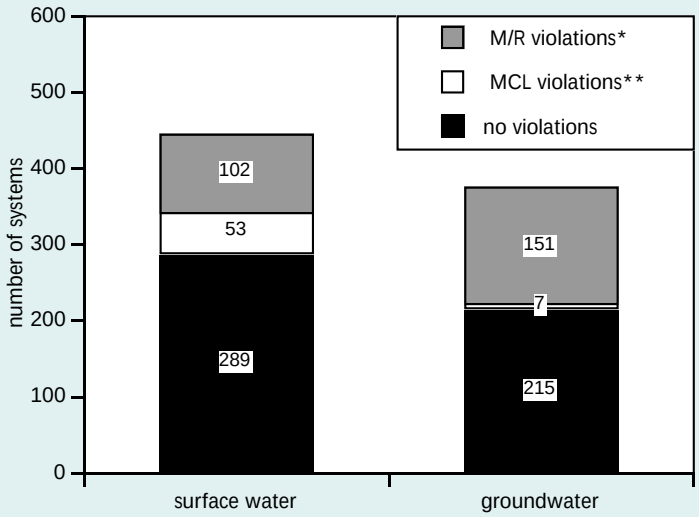
Figure 26
Violations of Selected Public Drinking Water Standards in Kentucky



*Note: Based on MCLs - Maximum Contaminant Levels - the federal standard set for the maximum amount of a contaminant that is allowed in treated water which is delivered to a consumer. *Trihalomethane monitoring not required prior to 1989. **More stringent turbidity standard took effect in 1993.*
Source: Kentucky Division of Water, 1994

Community drinking water systems are required to monitor and treat for 85 contaminants. The number of violations of public drinking water standards set to protect public health have varied during the past several years. The most common contaminants are bacteria (an indication water is contaminated with feces or other material), turbidity or cloudiness (which can interfere with the treatment process and allow pathogens to survive), trihalomethanes (organic chemicals created during the disinfection of water with chlorine), and inorganic chemicals (which include nitrates and a number of metals such as mercury and arsenic).

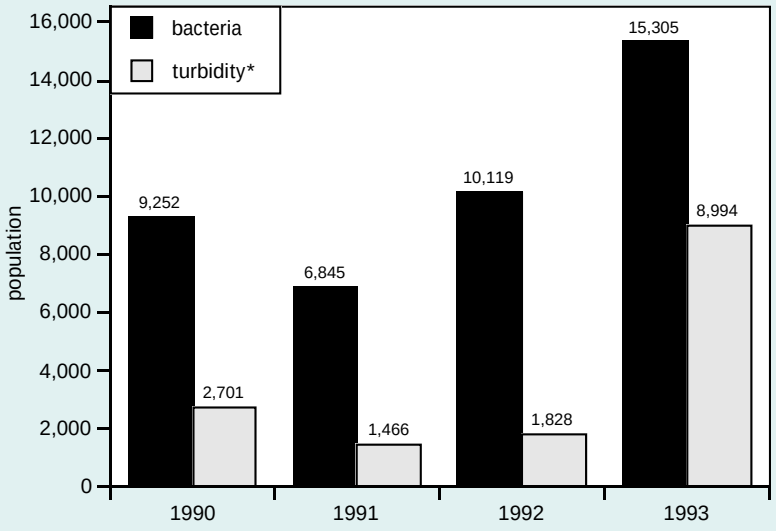
Figure 27
Drinking Water Violations in Kentucky by Supply Source



*Note: 1993 calendar year for all public systems. * M/R - monitoring and reporting violations. **MCLs - Maximum Contaminant Levels - the federal standard set for the maximum amount of a contaminant that is allowed in treated water which is delivered to a consumer.*
Source: Kentucky Division of Water, 1994

Violations of public drinking water standards during 1993 reveal that 13% of those systems supplied by surface water violated standards compared to 2% of the systems supplied by groundwater. State efforts have recently focused on preserving groundwater quality. Communities dependent on groundwater must develop plans to protect supplies by 1998. To date, 25 are in the process of developing wellhead protection plans to protect groundwater sources.

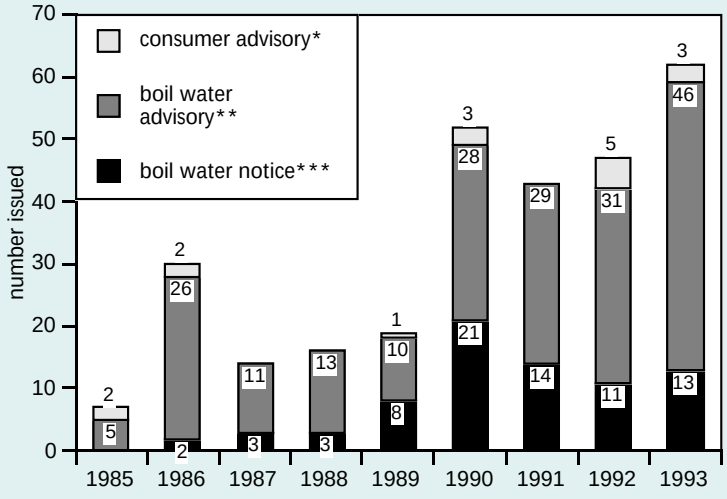
Figure 28
Population Served by Public Water Systems with Persistent Violations of Bacteriological and Turbidity Standards in Kentucky



*Note: Persistent violators are defined as those systems having four monitoring/reporting or MCL violations in a running calendar year. Population based on calculations of 3.3 persons per service connection. MCLs -Maximum Contaminant Levels - the federal standard set for the maximum amount of a contaminant that is allowed in treated water delivered to a consumer. *More stringent turbidity standard took effect in 1993.*
Source: Kentucky Division of Water, 1994

Thousands of Kentuckians have been served by public drinking water systems with persistent violations of bacteria and turbidity standards. It is difficult to fully determine the health impacts of waterborne pathogens in public drinking water because many gastrointestinal illnesses caused by bacteria, protozoa, or viruses in drinking water can be easily misdiagnosed. Symptoms caused by these organisms, such as nausea, vomiting, and abdominal discomfort can be mistaken for colds and the flu. The last known waterborne disease outbreak in Kentucky occurred in 1982 at Buttermilk Springs in Meade County causing 110 cases of hepatitis-A and one fatality. During 1990, an unconfirmed public drinking water outbreak of the bacteria Campylobacter, was suspected of causing 80 people in Fort Knox to get sick.

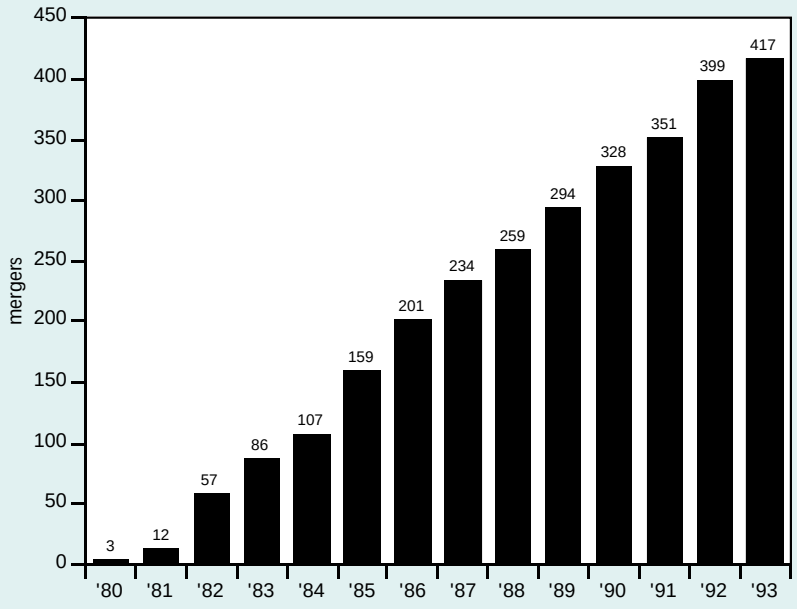
Figure 29
Drinking Water Advisories and Notices Issued in Kentucky



**Issued when chemical contamination is detected above standards. **Issued when there is potential for bacteriological contamination. ***Issued when evidence shows bacteriological contamination.*
Source: Kentucky Division of Water, 1994

The number of boil water notices and advisories issued due to bacterial contamination of public drinking water or the potential for contamination, continues to increase in Kentucky. The increase is attributed to better monitoring and reporting of waterline breaks by water providers. Waterline breaks can allow infiltration of contaminants and are responsible for many of the advisories. The detection of chemicals in drinking water above safe levels resulted in eight consumer advisories in 1992 and 1993.

Figure 30
Number of Drinking Water System Mergers in Kentucky*



**Cumulative yearly totals. Total includes 125 community, 229 transient non-community, and 63 non-transient non-community public drinking water systems.*
Source: Kentucky Division of Water, 1994

Kentucky has made some progress in improving drinking water quality by merging small poorly operated systems. Since 1980, 417 systems have been merged. Political boundaries and resources, however, continue to be major constraints to accomplishing more mergers in the state.

Figure 31
Selected Drinking Water Infrastructure Investments in Kentucky

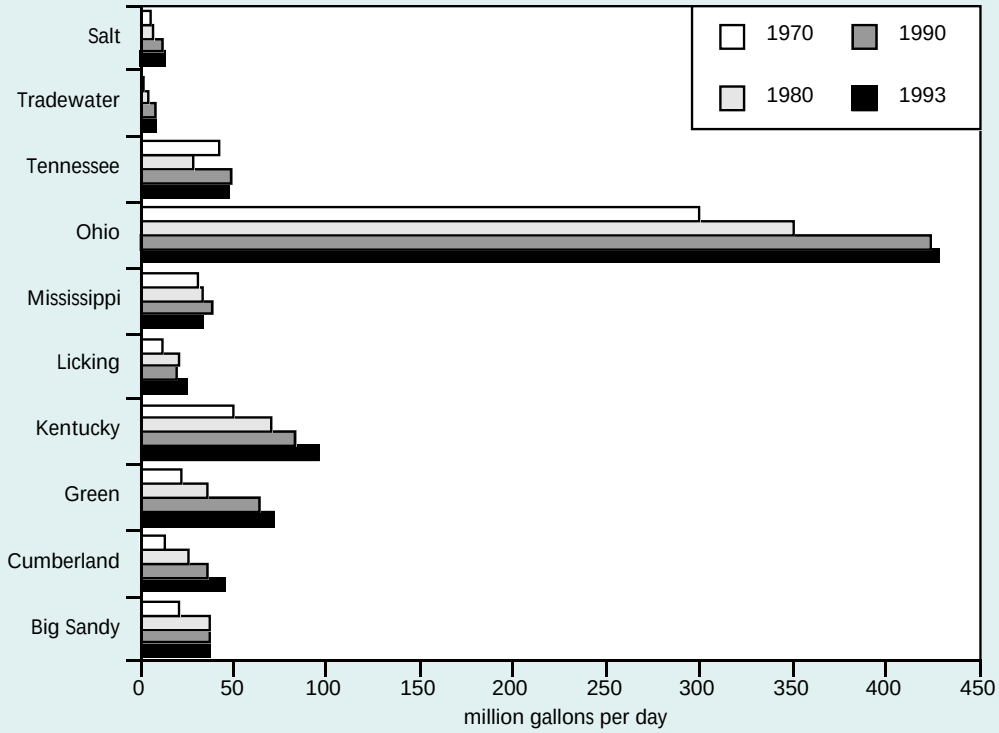
Source	# of Projects	$ Grants	$ Loans
USDA Farmers Home Adm.	150	$24,250,100	$49,869,300
Community Development Block Grants	43	$23,149,159	
KY Infrastructure Authority[1]	58		$61,078,993
U.S. Dept. Commerce EDA Grants[2]	12	$4,361,000	
Appalachian Regional Commission[3]	24	$5,297,750	
Abandoned Mine Land Program[4]	9	$1,166,000	
Total	**296**	**$58,224,009**	**$110,948,293**

Note: Calendar years 1992 and 1993 unless otherwise noted. There are other financial sources available for drinking water upgrades which are not included in this chart.
[1]Total project and loans approved July 1991-1993 from Kentucky Infrastructure Loan Funds B, B1, B2, and C. [2]Specific criteria to qualify (economic impact or job creation). [3]Grants limited to 49 Kentucky counties. [4]Includes funding for nine active waterline projects in 1992-94. Since 1983, $30.4 million has been awarded for 28 waterline projects in Kentucky under the abandoned mine land program.
Source: Kentucky Infrastructure Authority, U.S. Department of Agriculture, U.S. Department of Commerce, Appalachian Regional Commission, Kentucky Department of Surface Mining Reclamation and Enforcement, Kentucky Department of Local Government, 1994

The cost to maintain and upgrade public drinking water infrastructure is considerable. However, Kentuckians still pay, on average, only 62 cents a day for treated drinking water, according to data from suppliers regulated by the Public Service Commission. The Division of Water is currently conducting an assessment to determine drinking water infrastructure needs in the Commonwealth.

IV. Water Quantity Indicators

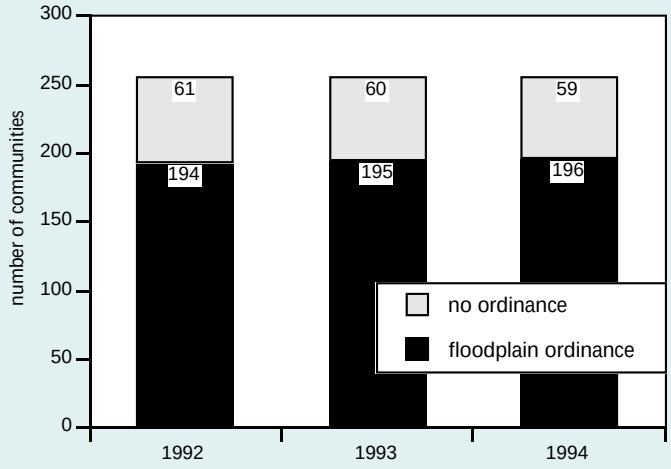
Figure 32
Permitted Water Withdrawals in Kentucky by River Basin



Note: Based on actual or estimated water use as reported by all permitted water users that average 10,000 gallons per day (gpd) or more. Agriculture, domestic (private water wells), and power plant water withdrawals exempt from state water withdrawal permitting requirements and are therefore not included in this chart. Not appearing on this chart are permitted withdrawals from the Lower Cumberland Basin 1992 and 1993 withdrawals at 100,000 gpd each year; Big Sandy Basin 1992 (1 million gpd) and 1993 (2 million gpd); and Tygarts Creek 1992 and 1993, 1 million gpd each year.
Source: Kentucky Division of Water, 1994

Permitted water withdrawals in some river basins, such as the Ohio and Kentucky, are increasing, reflecting residential and economic growth in various regions of the state. The variable distribution of water, however, has led to water shortages in a number of communities and 27 are still considered vulnerable to drought. Conflicts regarding water among users are also increasing, particularly in high-growth areas along low-flow streams. Ensuring adequate flow is a critical factor to maintaining stream health. However, the Division of Water often lacks adequate data on instream flow to protect aquatic habitat and other stream uses. Limited state efforts to monitor some low-flow but high-use streams are ongoing.

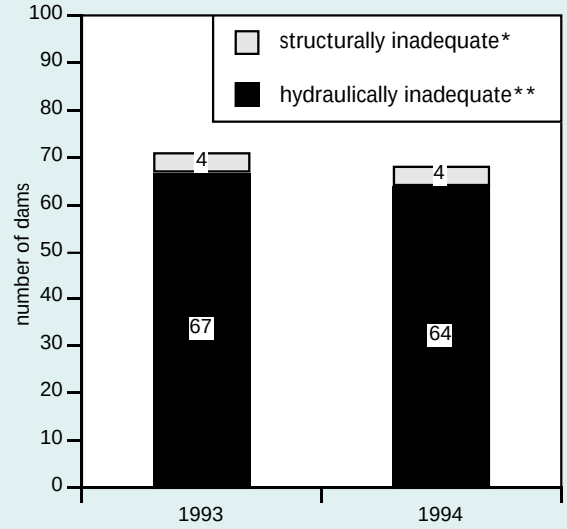
Figure 33
Floodplain Protection Ordinances in Kentucky*



**Based on communities in Kentucky identified by Federal Emergency Management Agency as vulnerable to flooding.*
Source: Kentucky Division of Water, 1994

Flooding occurs every year in Kentucky. Controlling development along floodplains to minimize property damage and protect lives remains a significant challenge. Fifty-nine of the 255 communities considered vulnerable to flooding still do not have local floodplain protection ordinances.

Figure 34
Unsafe Dams in Kentucky

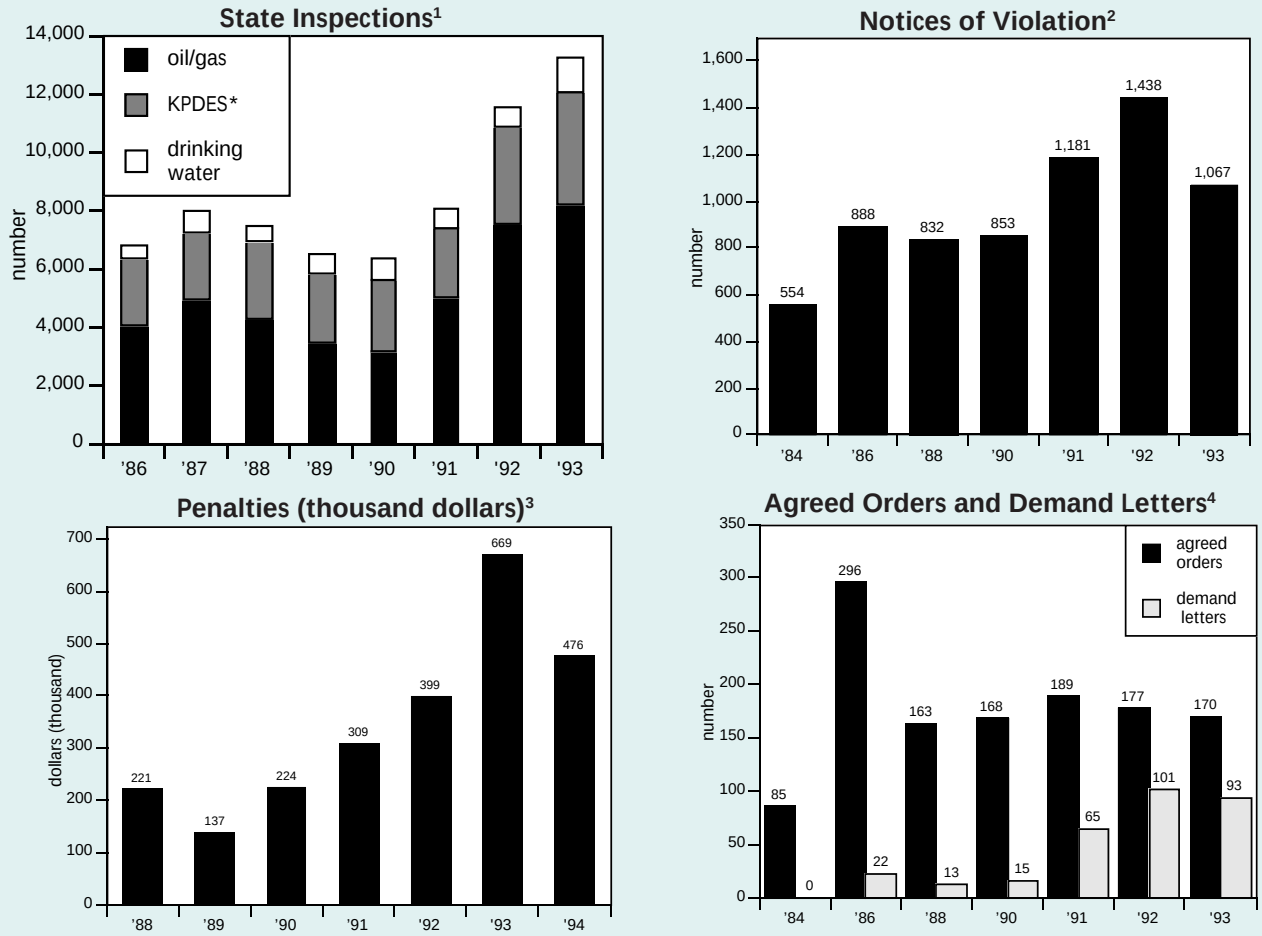


*Note: Earlier data not available. 908 total dams on state inventory. A dam is defined as measuring 25' in height, or containing 50 acre feet of water or more, or impoundments classified as high hazard. Does not include active surface mine impoundments or federally owned dams. *Structurally inadequate - the structure of the dam does not meet the minimum criteria set for dam safety. **Hydraulically Inadequate - spillway capacity is not sufficient for the safe passage of a possible flood.*
Source: Kentucky Division of Water, 1994

Sixty-eight of the 908 dams on the state inventory are considered unsafe due to structural or hydraulic problems. The Division of Water inspects dams for safety and has worked to bring dams within minimum safety standards. In some cases, enforcement actions such as fines and, on occasion, the draining of an impoundment, have been used to assure public safety. The division responded to only one dam emergency during the past two years.

V. Water Enforcement Measures

Figure 35
Water Enforcement and Compliance Measures

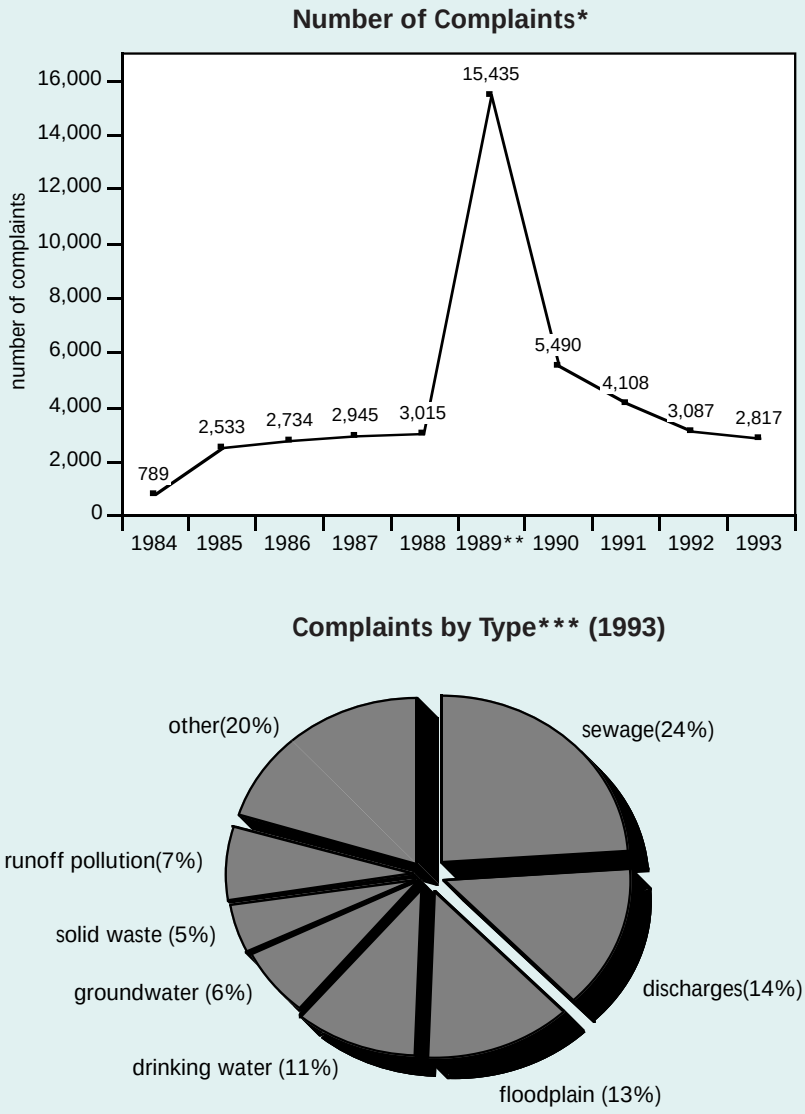


*[1]Chart does not include inspections of agriculture operations (216 in 1993), groundwater (182 in 1993), and complaint investigations (2,791 in 1993). *KPDES - Kentucky Pollutant Discharge Elimination System regulates 9,567 permitted discharges to waterways. The Division of Water (DOW) inspects the 3,000 industrial and municipal facilities and 1,800 industrial stormwater sources. The Department of Surface Mining inspects and regulates the 4,000 coal discharges with KPDES permits which are not included in this chart. [2]NOVs issued by the Division of Water Field Operations Branch. Other division branches also issue NOVs which are not included in this chart. [3]By fiscal year, includes fines paid and penalties collected from current and previous year cases. [4]Agreed orders and demand letters are enforcement tools which outline environmental violations, appropriate remedial measures, and civil penalties.*

Source: Kentucky Division of Water; Kentucky Division of Administrative Services, 1994

The Division of Water currently regulates 9,567 permitted water discharges from industrial, coal mining, and municipal sources. As of March 1994, 11% of the permitted industrial and municipal discharges were in significant noncompliance with permit limits, discharge limits, or reporting requirements. Enforcement of water quality rules, improved industry compliance, public and private sector investments, and voluntary measures to control runoff pollution have led to water quality improvements across the state. Kentucky has begun to move beyond the traditional regulatory approach to a more comprehensive water protection strategy that focuses on watershed management, local/state partnerships, and pollution prevention to achieve additional water quality improvements.

Figure 36
Citizen Complaints Regarding Water Quality Issues in Kentucky



**Data include only those complaints received by the Kentucky Division of Water. **The increased number of complaints reported for 1989 is attributed to public concerns about the Jamestown/Union Underwear discharge to Lake Cumberland/Lily Creek. ***Runoff pollution includes agriculture, logging, and other sources. Solid waste includes open burning, open dumping, illegal dumping, and tire dumps. Groundwater includes water well drilling, underground storage tanks, and other groundwater issues. Sewage includes domestic wastewater, houseboat sewage, septic tanks, straight pipes, and sewage bypasses. Discharges include illegal discharges, blackwater, commercial wastewater, facility spills, leaking cargo, oil/brine, stormwater, and transportation spills. Other includes wetlands, improper disposal, fish kills, dams, odors, and sedimentation.*
Source: Kentucky Division of Water, 1994

Kentuckians continue to voice concern regarding water pollution. Each year, thousands of citizen complaints are received by the Division of Water. Many are in regard to sewage and other improper discharges to waterbodies. Public involvement in the protection of local waterways is critical to restoring and maintaining water quality. A number of communities have become active through the state Community Stream and River Grant Program. The program, established in 1990, promotes community partnerships that foster water resource management and protection.

Chapter 2

Air Quality

Air Quality

Kentucky has made great progress during the past two decades in cleaning up the air while expanding economically. Air quality trends indicate that environmental quality and economic development can coexist. However, air pollutants still pose threats to the environment and human health.

This chapter reviews statewide efforts to reduce the risks of air pollution. Indicators track the level of pollution in the air as well as industrial emissions that contribute to air quality problems. Trends in air releases of toxic chemicals, a subject of public concern and expanding regulation nationwide, are analyzed to determine whether progress is being made in reducing these pollutants. This chapter also reviews other air quality issues including acid rain, ozone depletion, and compliance at permitted facilities.

Highlights

- Most regions of Kentucky currently comply with national air quality standards for six common air pollutants. Ozone pollution (smog) and sulfur dioxide remain the exception in some areas.
- 29% of Kentuckians (1.06 million) live in the eight counties that are currently designated as moderate nonattainment for ozone due to current or past violations of the health-based standard. The expected reclassification of five counties to attainment would reduce the affected population to 19%.
- During the 1990's, average air concentrations of nitrogen dioxide, carbon monoxide, particulates, and sulfur dioxide continued declining, as has generally been the case since the 1970 federal Clean Air Act was implemented.
- Sulfur dioxide emissions from coal-fired power plants in Kentucky declined about 49% since 1976, while the amount of coal burned increased 47%.
- Air releases of toxic chemicals from large manufacturers declined 18% between 1988 and 1992 in Kentucky as industries and regulators focused their attention on pollution prevention.
- Releases of pollutants linked to the depletion of the Earth's protective ozone layer declined 18% in Kentucky between 1991 and 1992.
- More that 3,000 sources of air pollution are regulated by the state. A record number of violations were cited at these plants in 1993. An estimated 4.5% of regulated facilities are currently under some type of enforcement action.

I. Air Quality

Air quality in monitored regions of the state generally continues to meet the national standards established for six pollutants—ground-level ozone (smog), nitrogen dioxide, carbon monoxide, particulate matter, lead, and sulfur dioxide—according to indicators presented in this chapter. However, the federal Clean Air Act Amendments of 1990 seek to further reduce air pollution nationwide to address problems such as acid rain, smog, toxic releases, and other air issues.

The act mandates that air pollutants associated with these problems be reduced by 56 billion pounds a year. The 1990 amendments will allow greater flexibility in implementation and increased use of efficient, market-based solutions to reduce emissions.

Ozone. The amount of ozone or smog in the air varies greatly among the different regions of the state. Ozone is primarily an urban air quality problem that is greatly influenced by weather conditions and emissions of volatile organic compounds and other pollutants from vehicles, power plants, industries, and small businesses.

Nationally, motor vehicles account for about half of the hydrocarbon and nitrogen oxide emissions that combine to create smog. Ground level ozone pollution is not related to the loss of the Earth's protective ozone layer.

Twenty-nine percent (1.06 million) of the state's population live in areas that are currently designated by the U.S. Environmental Protection Agency as "moderate nonattainment" for ozone because they have experienced problems meeting the standard. These areas include Jefferson, and a portion of Bullitt and Oldham counties; Northern Kentucky (Boone, Campbell, and Kenton counties); and the Ashland area (Boyd and a portion of Greenup County).

Moderate nonattainment areas must implement measures to reduce the pollutants, primarily nitrogen oxides and volatile organic compounds, that contribute to the formation of ground level ozone. Although some of these counties experienced exceedences of the health-based standard for ozone during the last three years, the Louisville Region is the only area currently violating the ozone standard. A violation occurs when more than three exceedences of the ozone standard occur during a three-year period at the same monitor.

The Kentucky Division for Air Quality has proposed to the U.S. EPA that the Northern Kentucky counties and the Ashland area be reclassified to attainment status for ozone because there have not been recent violations of the standard. The division expects approval on the redesignation request for both areas. If redesignation is approved, the number of Kentuckians living in moderate nonattainment areas within Jefferson, Bullitt, and Oldham counties will be approximately 701,000 (19%).

The Louisville area has implemented vehicle emissions testing and other controls to reduce emissions of pollutants that cause ozone pollution. However, the region must further reduce these emissions 15% below 1990 levels to bring the levels of ozone within the federal standard. Jefferson County is required to demonstrate through computer models that the standard will be met for 12 years.

Preliminary assessments, however, indicate Jefferson County will continue to experience difficulties meeting the ozone standard even with the emission reductions required under the Clean Air Act Amendments. The Jefferson County Air Pollution Control District has asked the U.S. EPA to adjust the computer model upon which the projections are based to more directly reflect actual conditions rather than what they consider to be the "worst case" scenario of the current model.

The state is developing a vehicle emissions testing program for the Northern Kentucky area to assist in reducing ozone problems in the region. The program is expected to be in operation by January 1996.

Nitrogen Dioxide. Indicators reveal that statewide air concentrations of nitrogen dioxide have declined 12% during the last three years. Long-term data generally reflects a 29% decline in the average amount of nitrogen dioxide in Kentucky's air between 1980 and 1993. Average nitrogen dioxide levels are generally declining in regions that have had consistent monitoring in recent years.

Carbon Monoxide. Nationally, automobiles emit up to 97% of the carbon monoxide released to the air. Carbon monoxide levels in Kentucky declined sharply between 1980 and 1992 in response to more stringent motor vehicle emissions control programs.

Most of the decline occurred between 1980 and 1985. Average air concentrations leveled off after 1985 due, in part, to the increasing number of vehicles and miles traveled.

Particulates. The amount of small airborne particles in the air is also monitored to ensure compliance with health-based standards. Particulates small enough to be trapped in the lungs are of increasing concern to the public and regulators as more is learned about their adverse effects on human health. Currently, all regions of the state meet the particulate standard.

The U.S. EPA is reviewing the national air quality standard for particulates due to concerns raised by the American Lung Association and other health advocates who contend the current standard is inadequate to protect health, especially for the young, the elderly, and people with chronic lung disease. The standard may become more stringent if warranted by health studies.

Sulfur Dioxide. Average air levels of sulfur dioxide in Kentucky have declined steadily during the last two decades as greater controls have been placed on coal-fired power plants and other sources. The controls were necessary to prevent adverse health effects and, more recently, to address acid rain. Emissions from power plants, the source of 90% of the sulfur dioxide released in Kentucky, declined 48% between 1976 and 1993.

Air Quality Control Regions

Source: Kentucky Division for Air Quality

The reductions in sulfur dioxide were achieved while the amount of coal burned in Kentucky increased 47% during this period. However, sulfur dioxide emissions began rising during the 1990's due to the increased demand and consumption of coal-fired electricity. Average air concentrations of this pollutant statewide did not significantly change between 1990 and 1993.

The acidity of Kentucky's rainfall is monitored at four sites that are part of the National Acid Precipitation Assessment Program. Monitoring at these sites indicates our rainfall has, on average, become slightly less acidic (increasing pH) since the assessment began. This is due to the controls placed on sources of sulfur dioxide, primarily coal-fired power plants.

The 1990 Clean Air Act Amendments call for a 40% reduction in sulfur dioxide emissions from power plants by the turn of the century, using 1980 as the baseline. Kentucky facilities achieved a 26% reduction in sulfur dioxide emissions between 1980 and 1993.

Power plants that release the most sulfur dioxide are targeted for the first round of emission reductions which began January 1, 1995. Utilities have the option to install pollution control equipment, such as scrubbers, switch to low-sulfur fuel, or trade emission allowances with other plants to achieve the reductions.

In Kentucky, most coal-fired power plants affected by the first phase of reductions have opted to install scrubbers or continue using a combination of low and high-sulfur coal. Nationally, of the 261 generating units affected by the first phase of the program, 162 have changed to low-sulfur fuels, and 27 installed new scrubbers, according to the U.S. Department of Energy.

Indoor Air. In addition to the health risks associated with outdoor air pollution, evidence reveals that the air quality in homes and buildings can be more polluted and a greater threat than outdoor air.

One such indoor air pollutant is radon, a naturally-occurring, invisible and odorless gas considered to be a leading source of lung cancer. Surveys indicate that radon levels exceeded health limits in 17% of the homes tested in the state. However, only 14% of the homes statewide and 20% of the homes in high risk areas have been tested for radon problems.

Fourteen Kentucky counties are classified as high radon activity areas by the U.S. EPA. High risk areas include: Barren, Bourbon, Bullitt, Cumberland, Fayette, Franklin, Hart, Jefferson, Jessamine, Marion, Nelson, Pulaski, Scott, and Warren counties.

The Human Resources Cabinet, Radiation Control Program, and the U.S. EPA have focused efforts to educate the public about radon in the areas of the state considered at highest risk. Seventeen local health departments and districts in high risk areas have been awarded grants to conduct radon awareness programs to encourage testing and remediation when problems are detected.

II. Air Toxics

Air releases of toxic chemicals have been of increased concern in recent years as more is learned about their potential health and ecological effects. The U.S. EPA has established standards for only eight air toxics to date. However, the agency is now mandated, by the new Clean Air Act Amendments, to set standards for 189 other toxic pollutants over the next 10 years.

Although Kentucky has air toxics regulations, few facilities have been required to reduce toxic air releases as a result of the state program. The Division for Air Quality indicates the regulation has been used primarily to determine whether proposed toxic air emissions from facilities requesting environmental permits would cause air concentrations of a toxic pollutant to exceed safe levels.

The 1990 Clean Air Act Amendments require sources to install maximum available control technology (MACT) to reduce emissions of listed hazardous air pollutants. The act also mandates an assessment of the risk remaining to the public from emissions occurring after the installation of MACT. Full implementation of the air toxics provisions of the act is projected to take more than a decade.

Assessing the potential impacts of toxics to exposed people and the environment is a difficult process. The state is coordinating "geographic initiatives," ongoing projects that are evaluating the combined effects of toxic releases in two highly industrialized areas: Calvert City in Marshall County and the Ashland area along the Kentucky/West Virginia border.

Toxic Releases/Transfers. Large manufacturers have been required to report toxic chemical releases and transfers for further treatment, recycling, or disposal since 1988. During 1992, 39 million pounds of toxics were released to the air by reporting industries.

Nearly 45% (17.2 million pounds) of these releases involved 17 chemicals that have been prioritized by the U.S. EPA for reduction because they are considered highly toxic, carcinogenic, or are released in large volumes.

Many industrial facilities in Kentucky have joined the voluntary "33/50" Program sponsored by the U.S. EPA to reduce industrial emissions of the priority toxic chemicals. The majority of these chemicals are solvents that are typically released to the air.

Air releases of priority toxics were reduced 23.5% between 1988 and 1992, indicating important progress in reducing potential adverse health and environmental effects.

III. Ozone Depletion

Worldwide attention has been focused on the depletion of the stratospheric ozone layer. The ozone layer shields the Earth's surface from radiation and influences heating and cooling of the Earth and its atmosphere. Many scientists believe the ozone layer is thinning as a result of the use of certain chemicals, which include chlorofluorocarbons (CFCs) used as refrigerants, halons, and others. Stratospheric ozone depletion has been linked to skin cancer and changes in global climate patterns.

Kentucky industries have continued their trend toward reducing emissions of ozone destroying chemicals due to the international phaseout of CFCs and other disincentives mandated by the Clean Air Act Amendments. Between 1991 and 1992, industrial facilities reported an 18% decline in air releases of 11 chemicals thought to destroy the ozone layer.

IV. Enforcement and Compliance Measures

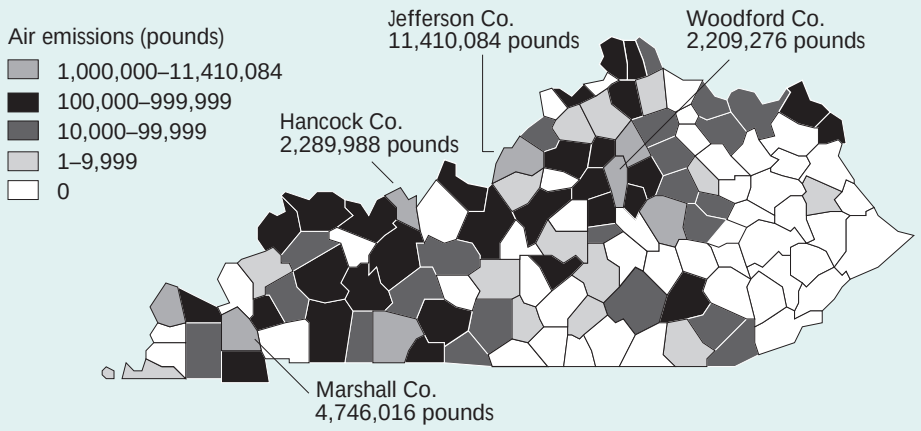
There are more than 3,000 regulated air pollution sources in Kentucky. These include large industries and other facilities that release air contaminants. The Kentucky Division for Air Quality and the Jefferson County Air Pollution Control District oversee permitting and inspections of these facilities to ensure compliance with air permit conditions designed to maintain air quality standards.

The number of violations cited by the Division for Air Quality grew 183% between 1984 and 1993, while the number of inspections increased 75% during that period. The increased number of citations is attributed, in part, to the addition of the asbestos control program. The Division collected record penalties for air quality violations during fiscal year 1990-91 and a large settlement in fiscal year 1992-93 due to violations at one facility.

The costs associated with carrying out the provisions of the new Clean Air Act Amendments are high, estimated nationally at $25 billion a year when fully implemented in the year 2005, according the U.S. EPA. Many regulated sources in Kentucky will pay increased fees based on air pollutant emissions, as authorized under the act, to assist the Division for Air Quality issue permits and implement the new requirements of the law. The Division for Air Quality collected emission fees of $2.6 million in state fiscal year 1994, nearly $5.5 million in 1995, and expects to collect $6.59 million in 1996.

The fees will also be used to fund a center to help small businesses comply with the act. The Small Business Technical Assistance Center was established in 1994 at the University of Kentucky to assist small businesses estimate air pollutants, apply for permits, and reduce air emissions.■

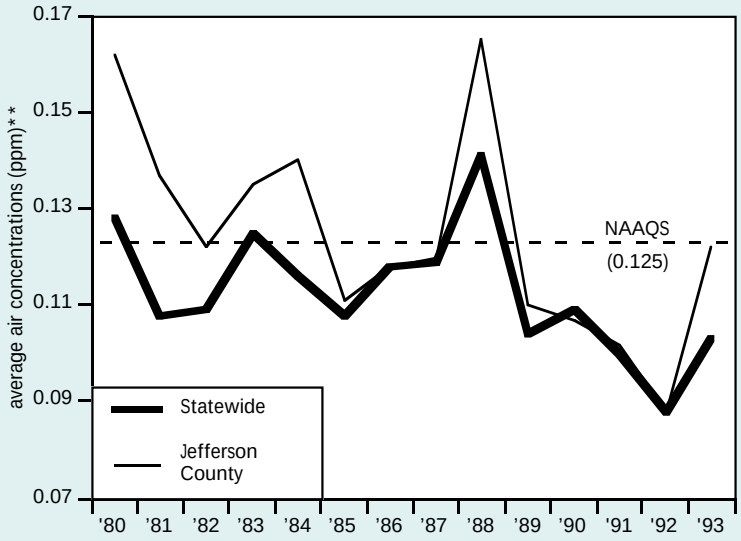
Toxic Air Emissions and Counties with Top Releases in Kentucky



Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Report, 1992

I. Air Quality Indicators

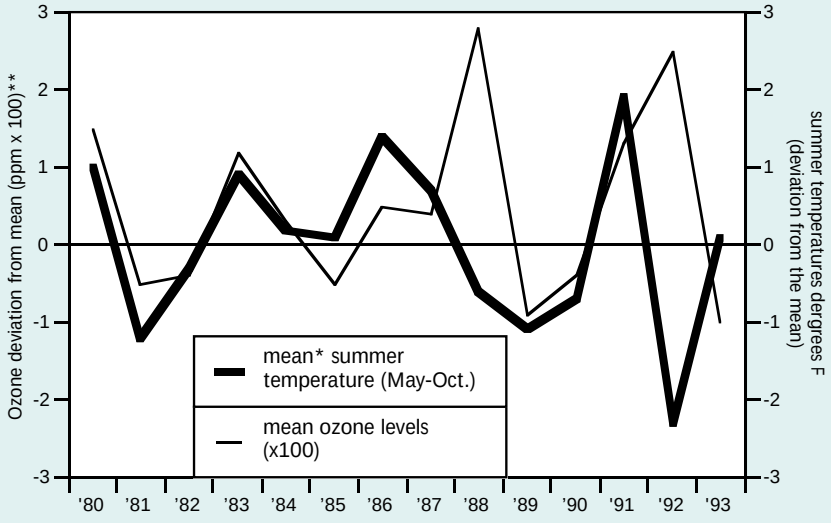
Figure 1
Statewide Air Concentrations of Ozone*



*Note: Based on 2nd maximum one-hour average. Averages are compared to the NAAQS—National Ambient Air Quality Standard established to protect human health and the environment. *The averages, as shown in this figure are not used to determine compliance with national air quality standards and do not reflect the daily exceedences of the standards that cause Jefferson County to be listed as an ozone nonattainment area.*
***ppm—parts per million*
Source: Kentucky Division for Air Quality, 1994

Pollution from automobiles, factories, and other sources contribute to ozone problems. Ozone levels are monitored by the Division for Air Quality at 30 sites in the state. Average ozone levels indicate air quality in Kentucky generally is within acceptable levels. However, Jefferson County continues to experience problems controlling ground level ozone despite increasing efforts to reduce smog forming pollutants.

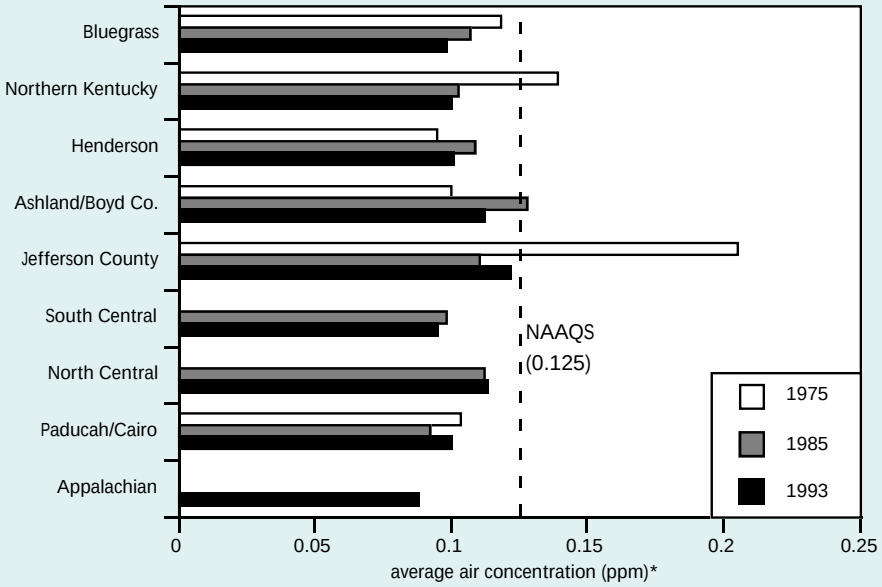
Figure 2
Summer Temperatures* Compared to Ozone Levels in Kentucky Air



*Note: Ozone averages based on 2nd maximum one-hour average. *Deviation from the mean.*
***ppm—parts per million*
Source: Kentucky Division for Air Quality; Western Ky. University, Kentucky Climate Center, 1994

Ozone pollution is heavily influenced by weather conditions and is most problematic during hot, dry summer months when the air is typically stagnant. Average temperatures appear to follow the same general trends as average ozone levels in the air. An apparent exception to this trend occurred during 1988 and 1992 when ozone violations occurred but overall temperatures were below average. However, temperatures during the summer months of these years were high which would explain the lack of correlation between temperature and ozone levels during these times.

Figure 3
Regional Concentrations of Ozone in the Air



*Note: Based on 2nd maximum one-hour average. Appalachian Region monitoring began in 1993. Averages are compared to the NAAQS—(National Ambient Air Quality Standard) established to protect human health and the environment. *PPM—parts per million.*
Source: Kentucky Division for Air Quality, 1994

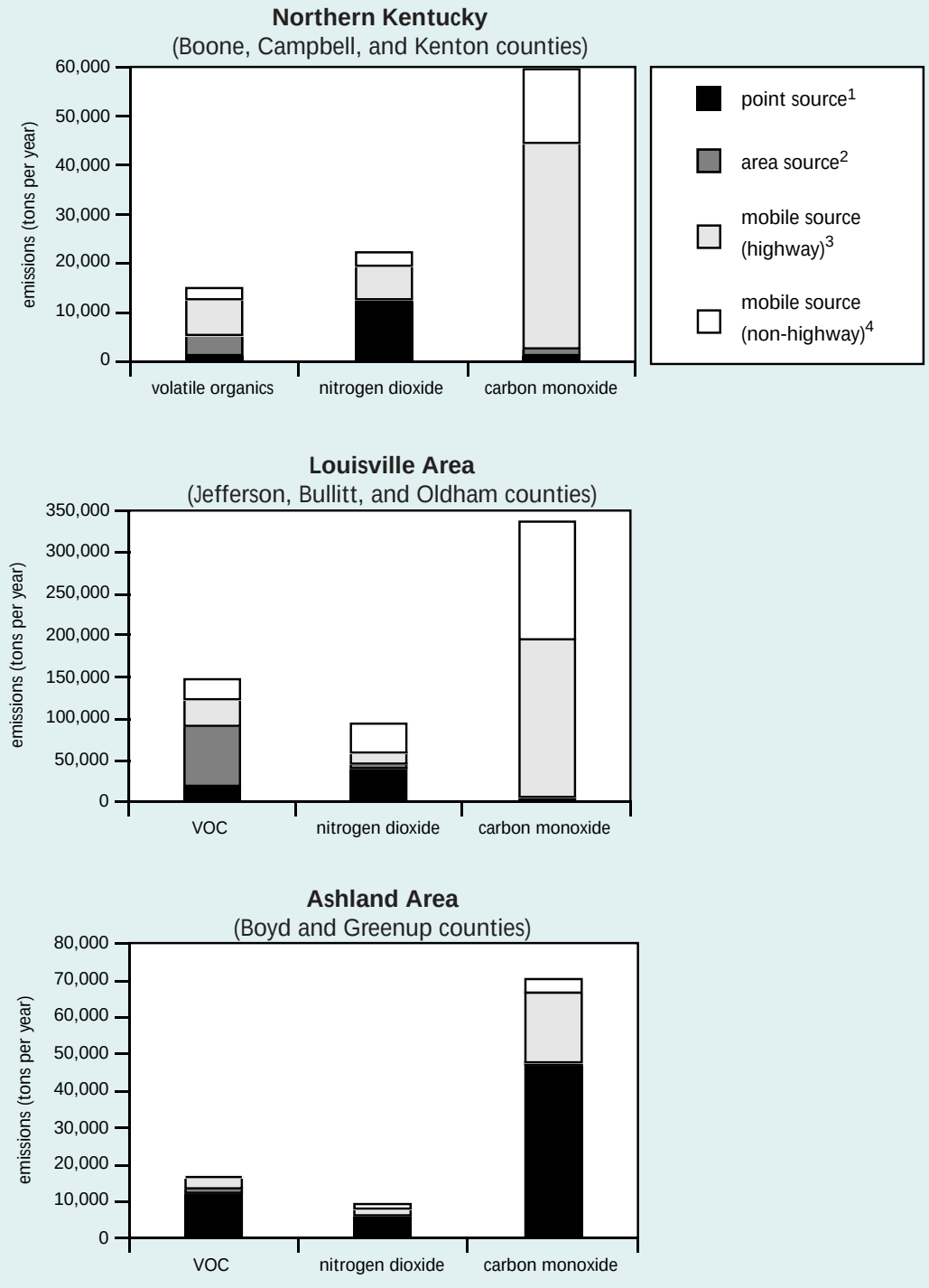
The Jefferson County Kentucky/ Southern Indiana Interstate Region is the only area violating the ozone standard, and only by a narrow margin. The region exceeded the standard three days in 1993 and four days in 1994. A violation occurs when the standard is exceeded more than three times in a three year period at the same monitor, based on monitoring and calculated data. Ozone-forming pollutants are typically transported across the river from Jefferson County to Southern Indiana. Many reported exceedences of the standard occur at the Charlestown Indiana monitor after pollutants have had time to "react" and form smog. Other ozone nonattainment areas including Northern Kentucky and Ashland/Boyd County have not violated the ozone standard during the last three years, although some exceedences have been recorded.

Figure 4
Number of Days Ozone Standards Exceeded by Region

	Bluegrass	N. Kentucky	Henderson	Ashland/Boyd	Jefferson Co.	Paducah	N. Central	S. Central	Appalachian
1985	0	1	1	3.1	1.3	0	0	0	NM
1986	2.1	1	1	3.1	2.4	2	3.1	0	NM
1987	1.1	2	1	5.9	7.4	0	2	1.1	NM
1988	5	14.1	10.2	10.4	7.7	4	9.7	5.2	NM
1989	0	1.1	0	1	4	0	0	0	NM
1990	1	0	3	4.6	1.1	0	2.1	0	NM
1991	0	0	0	3.1	0	0	1.1	0	NM
1992	0	0	0	0	0	0	0	0	0
1993	0	1	0	1	3	1	1.2	0	0

Note: Based on the expected number of days (which is the standard) in violation of the ozone standard, determined by actual monitoring data and calculations that account for incidents when monitors didn't operate or data is unrecoverable. NM—not monitored.
Source: Kentucky Division for Air Quality, 1994

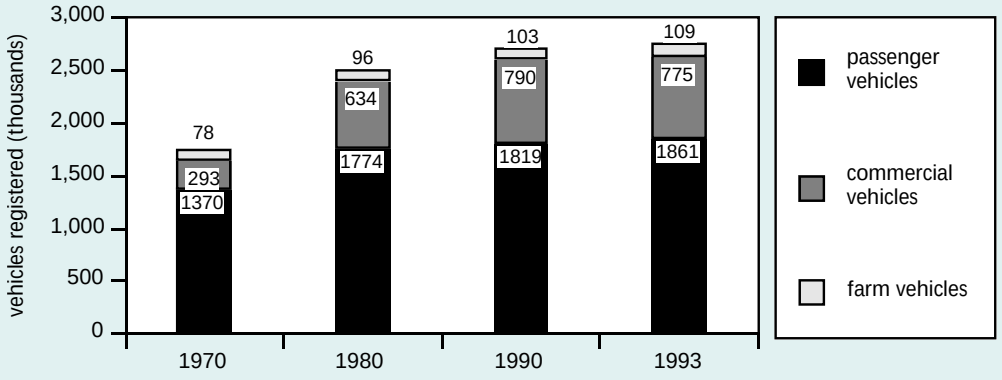
Figure 5
Sources that Contribute to Ozone Pollution in Kentucky



Note: Data based on the 1990 Emissions Inventory for Kentucky's moderate ozone nonattainment areas. [1]Point sources include large permitted stationary facilities. [2]Area sources include smaller sources such as gas stations, dry cleaners, and other nontraditional sources of emissions. [3]Highway mobile sources include cars, trucks, and other vehicles used for transportation. [4]Nonhighway mobile sources include airplanes, locomotives, heavy equipment, and other vehicles.
Source: Kentucky Division for Air Quality, Jefferson County Air Quality Control District, 1994

Sources of pollutants that cause ozone problems vary by region. Automobiles and other vehicles account for most of the volatile organic compounds (VOC) and carbon monoxide emitted in the Jefferson County region and the Northern Kentucky counties. However, industrial releases of VOCs, carbon monoxide, and nitrogen dioxide emissions are the dominate source of ozone in the Ashland area. Efforts to curb ozone pollution in nonattainment areas vary and include vehicle tailpipe testing, the use of reformulated gas, vapor controls at gas pumps, and reduction of industrial VOC releases.

Figure 6
Number of Registered Vehicles in Kentucky



Source: Kentucky Transportation Cabinet, 1995

There are currently 2.75 million registered vehicles in Kentucky. Vehicles account for a significant portion of some pollutants that cause air quality problems, particularly ozone (smog) pollution in urban areas. Improved controls on vehicle emissions are being offset by the increasing number of vehicles on the road and the fact that average personal vehicle miles traveled have more than doubled since 1970.

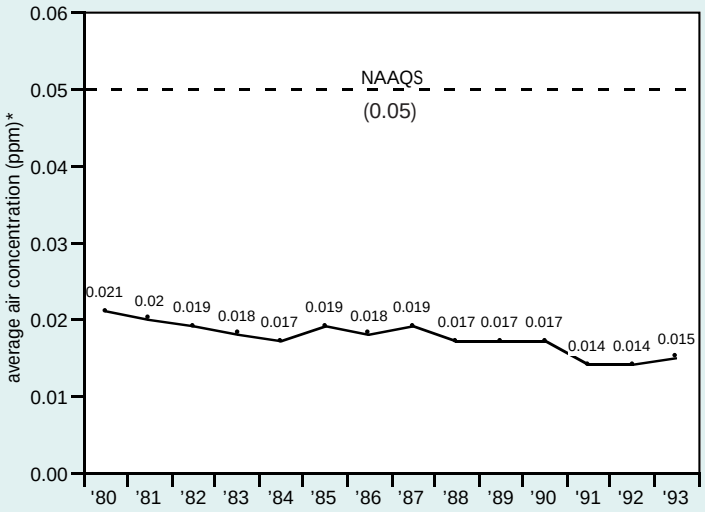
Figure 7
Number of Kentuckians Living in Moderate Ozone Nonattainment Areas * (1994)

County	Total Population	High Risk Population**
Boone	57,589	18,310
Campbell	83,866	28,775
Kenton	142,031	47,693
Jefferson	664,937	216,890
Bullitt***	19,267	6,454
Oldham***	16,774	5,619
Boyd	51,150	16,712
Greenup***	23,293	7,803
Total Population	**1,058,907**	**348,256**
% State Population	**29%**	**9%**

Note: Population percent based on 1990 Census of 3,685,296.
**Nine other counties are currently designated as marginal nonattainment for ozone but are not included in this chart. The Division for Air Quality has requested these counties be reclassified to attainment since no violations of the standard have occurred in recent years. ** High risk population includes persons considered more susceptible to adverse health effects because they are under age 13, or over 65. Persons outside these age groups who are asthmatic, or have chronic bronchitis or emphysema are not included because data was incomplete. ***Only a portion of Greenup, Bullitt, and Oldham counties are designated as nonattainment.*
Source: Kentucky Division for Air Quality, State Data Center, American Lung Association, 1994

Approximately 29% of Kentuckians (1.06 million) live in areas that have experienced significant problems meeting the health-based standard for ozone. Jefferson, Boone, Kenton, Campbell, and Boyd counties, and portions of Oldham, Bullitt, and Greenup counties are currently classified as moderate nonattainment for ozone. The Northern Kentucky counties and Boyd and Greenup counties are expected to be reclassified to attainment status because no violations of the standard have occurred in the last three years. Redesignation of these areas would reduce the number of persons living in moderate nonattainment areas to 701,000 (18.5%).

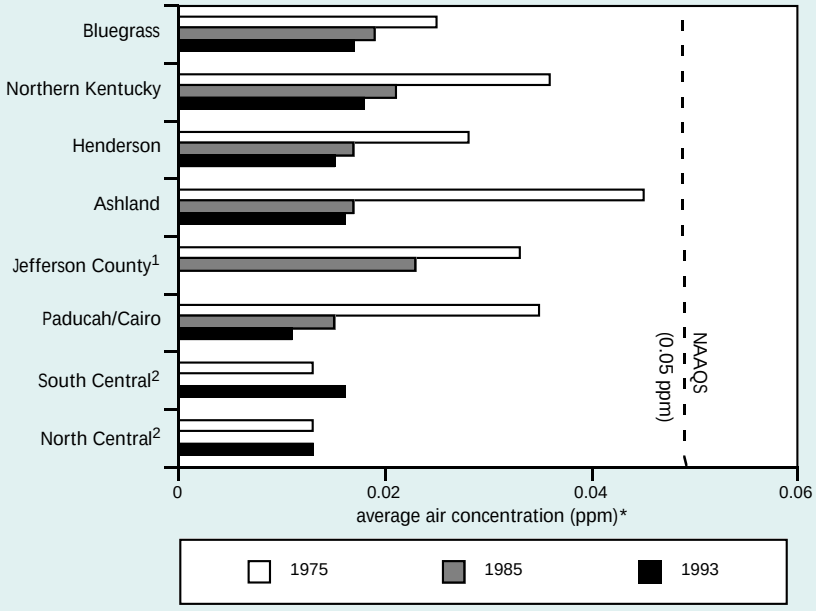
Figure 8
Statewide Average Air Concentrations of Nitrogen Dioxide



*Note: Based on annual statewide average. Averages are compared to the NAAQS (National Ambient Air Quality Standard) established to protect human health and the environment. *ppm—parts per million.*
Source: Kentucky Division for Air Quality, 1994

There are 11 monitors in Kentucky that measure the level of nitrogen dioxide in the air. The average air concentration of nitrogen dioxide during 1993 was nearly 29% lower than levels recorded in 1980. The general decline in nitrogen dioxide is attributed to emission controls on vehicles. However, the increasing number of vehicles on the road may be offsetting these reductions.

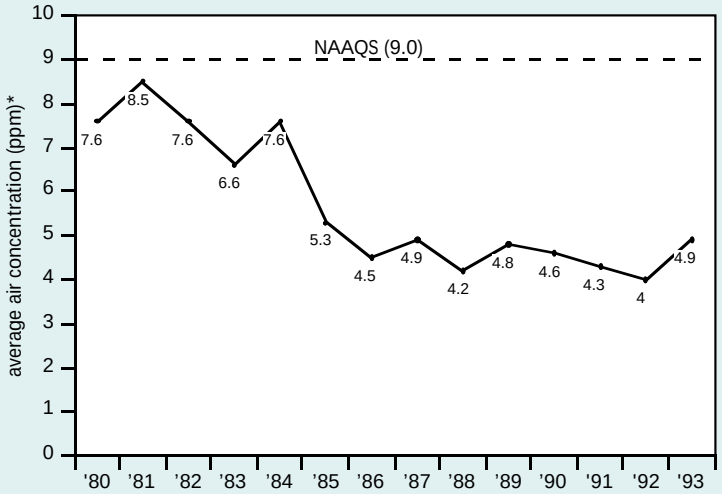
Figure 9
Regional Air Concentrations of Nitrogen Dioxide in Kentucky



*Note: Based on annual averages. Averages are compared to the NAAQS (National Ambient Air Quality Standard) established to protect human health and the environment. The Appalachian Region is no longer monitored for nitrogen dioxide. [1]Jefferson County data not available for 1993 due to data recovery problems. [2]South Central and North Central regions not monitored during some years. *ppm—parts per million.*
Source: Kentucky Division for Air Quality, 1994

The average air concentration of nitrogen dioxide has declined steadily in six of the eight monitored regions since 1975. All monitored regions of Kentucky continue to meet the national air quality standard for nitrogen dioxide. The 1990 Clean Air Act mandates additional controls on some stationary sources that emit nitrogen dioxide.

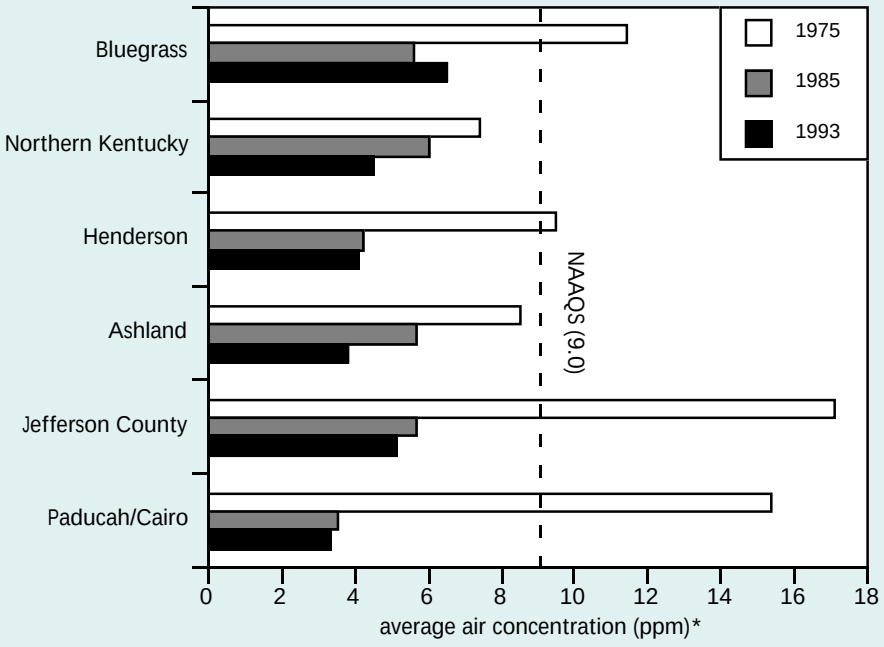
Figure 10
Statewide Average Air Concentrations of Carbon Monoxide



Note: Based on 2nd maximum, 8-hour average. NAAQS (National Ambient Air Quality Standard) established to protect human health and the environment.
**ppm—parts per million*
Source: Kentucky Division for Air Quality, 1994

Carbon monoxide pollution has been significantly reduced nationwide and in Kentucky due to vehicle emission control devices. Most of the reduction in carbon monoxide levels occurred between 1980 and 1985. Average air levels since 1985 have generally leveled off at the 13 sites with carbon monoxide monitors. Industrial sources of carbon monoxide have also been required to control emissions of this pollutant.

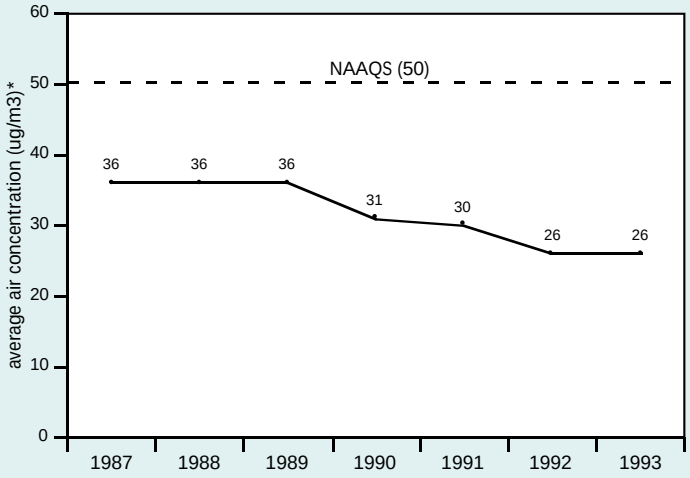
Figure 11
Regional Concentrations of Carbon Monoxide in Kentucky



*Note: Based on 2nd maximum, 8-hour average. NAAQS (National Ambient Air Quality Standard) established to protect human health and the environment. *ppm—parts per million.*
Source: Kentucky Division for Air Quality, 1994

All regions of Kentucky are currently in compliance with the carbon monoxide standard. Average air concentrations have markedly declined since the 1970's in all monitored regions. Improved vehicle inspection and maintenance programs required in Jefferson County and a new vehicle emission testing program slated to begin in 1996 in Northern Kentucky are expected to further reduce carbon monoxide levels in those areas.

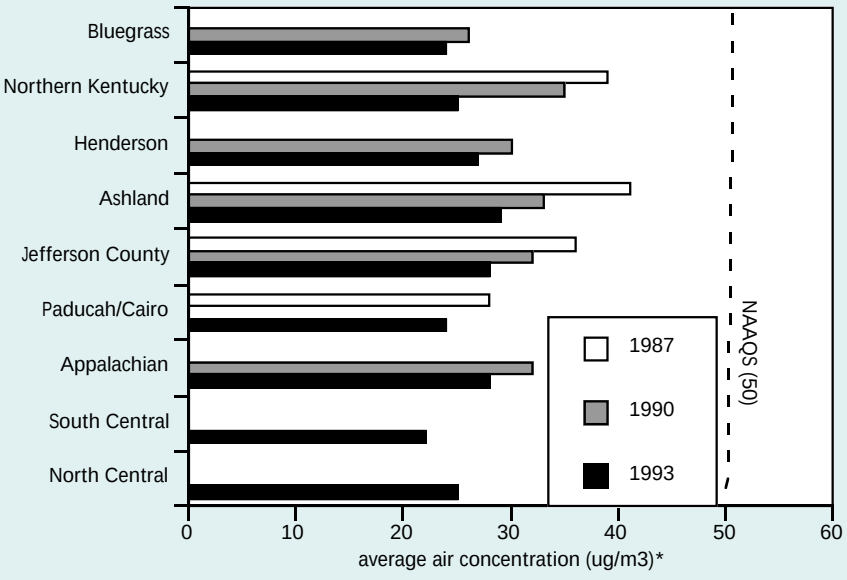
Figure 12
Statewide Air Concentrations of Particulates



*Note: Based on annual average. Averages are compared to the NAAQS—National Ambient Air Quality Standard established to protect human health and the environment. *ug/m3—micrograms per cubic meter.*
Source: Kentucky Division for Air Quality, 1994

The apparent decline in air concentrations of small airborne particulates that can get trapped in the lungs, is not due to any specific control strategy employed by the state, according to the Division for Air Quality. The change is likely a reflection of increased monitoring statewide, weather conditions, and measures employed to reduce dust and other emissions. Kentucky currently has 37 particulate monitors. These monitors measure smaller particles than did earlier monitoring. Major sources of particulates include coal-fired power plants, coal handling facilities, and rock quarries.

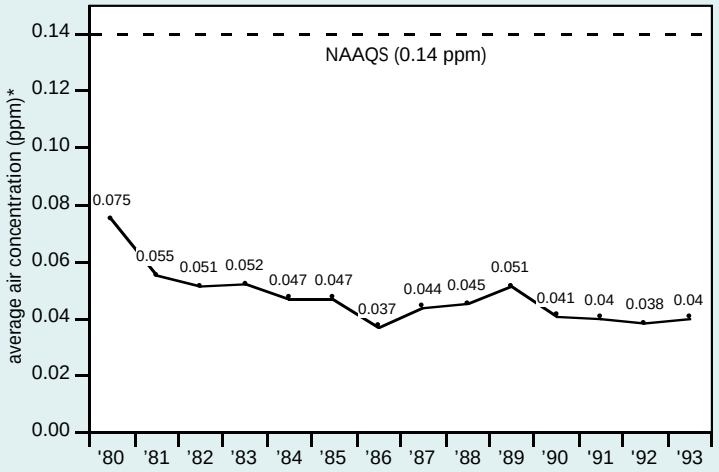
Figure 13
Regional Air Concentrations of Particulates in Kentucky



*Note: Based on annual average. Averages are compared to the NAAQS (National Ambient Air Quality Standard) established to protect human health and the environment. The PM10 standards was established in 1987 for particulates 10 microns in size. Some regions were not monitored during all years. *ug/m3—micrograms per cubic meter.*
Source: Kentucky Division for Air Quality, 1994

Smaller airborne particles (those less than 10 microns in size) are most directly associated with adverse health impacts. Currently, average particulate levels in all regions are within acceptable limits. However, the U.S. EPA is presently reviewing the standard to determine if it needs to be made more stringent to protect human health.

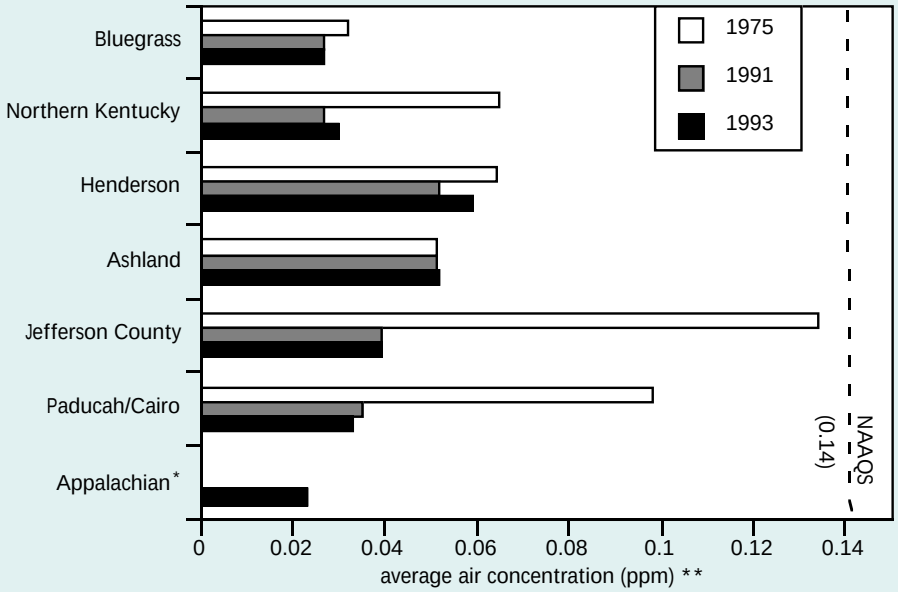
Figure 14
Statewide Average Air Concentrations of Sulfur Dioxide



*Note: Based on annual averages. Averages are compared to the NAAQS (National Ambient Air Quality Standard) established to protect human health and the environment. *ppm—parts per million.*
Source: Kentucky Division for Air Quality, 1994

The average air concentration of sulfur dioxide in Kentucky during 1993 was nearly 50% lower than levels recorded in 1980. Sulfur dioxide is currently the focus of intensified control strategies, primarily aimed at coal-fired power plants, due to its association with acid rain. Sulfur dioxide is monitored at 15 locations in the state.

Figure 15
Regional Concentrations of Sulfur Dioxide in Kentucky



*Note: Based on 2nd maximum, 24-hour averages. Averages are compared to the NAAQS (National Ambient Air Quality Standard) established to protect human health and the environment. *Earlier data not available for the Appalachian Region. Sulfur dioxide monitoring is not done in the North Central and South Central regions. **ppm—parts per million.*
Source: Kentucky Division for Air Quality, 1994

Sulfur dioxide levels within all monitored regions of the state generally fall within acceptable limits. Most regions have experienced decreasing air concentrations of sulfur dioxide. This is largely due to the use of scrubbers and other air pollution controls placed on coal-fired power plants and industries.

Figure 16
Sulfur Dioxide Emissions from Power Plants in Kentucky

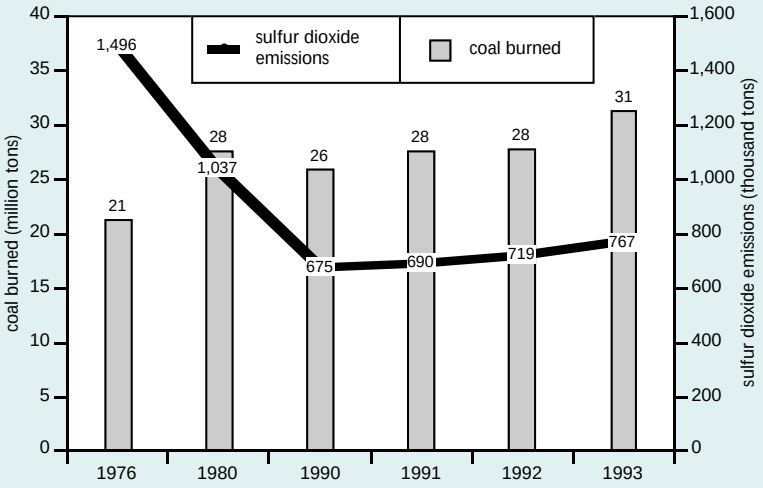
County	Facility	1976 (tons emitted)	1980 (tons emitted)	1993 (tons emitted)	1980-93 (% change)
McCracken	TVA-Shawnee	288,000	86,961	44,431	-48.9
Muhlenburg	Kentucky Utilities-Green	27,000	13,529	15,362	13.5
Muhlenburg	TVA-Paradise	456,000	372,654	175,040	-53.0
Ohio	Big Rivers Electric-Wilson	NA	NA	7,695	
Daviess	OMU Elmer Smith	74,000	45,159	69,855	54.7
Hancock	Big Rivers Electric-	100,000	78,650	58,793	-25.2
Henderson	Henderson Mun. Power	9,000	1,526	1,638	7.3
Webster	Big Rivers Electric-Reid	81,000	53,443	30,547	-42.8
Webster	Big Rivers Electric-Green	NA	7,618	7,569	-0.6
Boone	Cincinnati Gas & Electric	NA	NA	14,929	
Carroll	Kentucky Utilities-Ghent	76,000	84,553	117,036	38.4
Bell	Kentucky Utilities-	1,000	467	564	20.8
Clark	E. KY Rural Electric-Dale	8,000	3,929	6,819	73.6
Fayette	Kentucky Utilities*	5	5	5	0.0
Mercer	Kentucky Utilities-	57,000	53,153	42,177	-20.6
Woodford	Kentucky Utilities-Tyrone	2,000	1,081	862	-20.3
Lawrence	KY Power-Big Sandy	60,000	61,617	55,032	-10.7
Mason	E. KY Power Co.-	NA	19,322	43,258	123.9
Pulaski	E. KY. Power Co.-	35,000	12,743	21,631	69.7
Jefferson	LG&E-Mill Creek	112,039	107,491	35,054	-67.4
Jefferson	LG&E-Cane Run	109,578	32,904	6,798	-79.3
Trimble	LG&E-Trimble	NA	NA	12,411	
State Total		**1,496,417**	**1,036,805**	**767,506**	**-26.0**

*Note: NA indicates the facility did not operate during the year. *Not a coal-fired facility.*
Source: Kentucky Division for Air Quality, Air Pollution Control District of Jefferson County, Louisville Gas and Electric, East Kentucky Power, 1994

The 1990 Clean Air Act Amendments call for a 40% reduction in sulfur dioxide emissions by the turn of the century, using 1980 as the baseline. The two-phase program will affect all coal-fired power plants in varying degrees. Facilities may install scrubbers or other pollution controls, use lower sulfur fuel, or purchase "emissions allowances" from other sources to meet their emission limits. Overall, Kentucky power plants reduced sulfur dioxide emissions 26% between 1980 and 1993. It should be noted that collective emissions dropped even more sharply, 49%, between 1976 and 1993, reflecting earlier efforts made by some power plants to curb sulfur dioxide releases.

Figure 17

Coal Burned Compared to Sulfur Dioxide Emissions from Power Plants in Kentucky

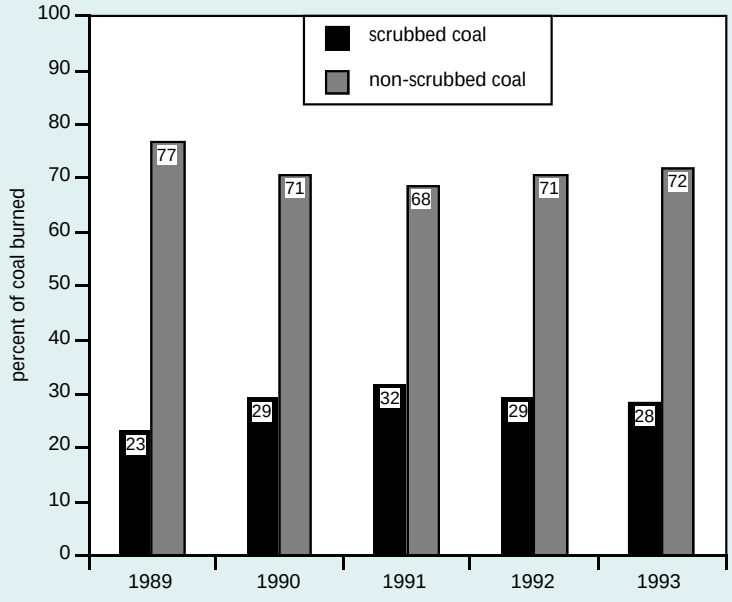


Source: Kentucky Division for Air Quality, 1994

The amount of coal burned at power plants in Kentucky increased 47% between 1976 and 1993. However, sulfur dioxide emissions declined approximately 49% during this same time. Several facilities added pollution controls to meet air quality standards in earlier years. Further reductions in sulfur dioxide to control acid rain are mandated by the federal Clean Air Act Amendments of 1990.

Figure 18

Coal Burned by Power Plants in Kentucky

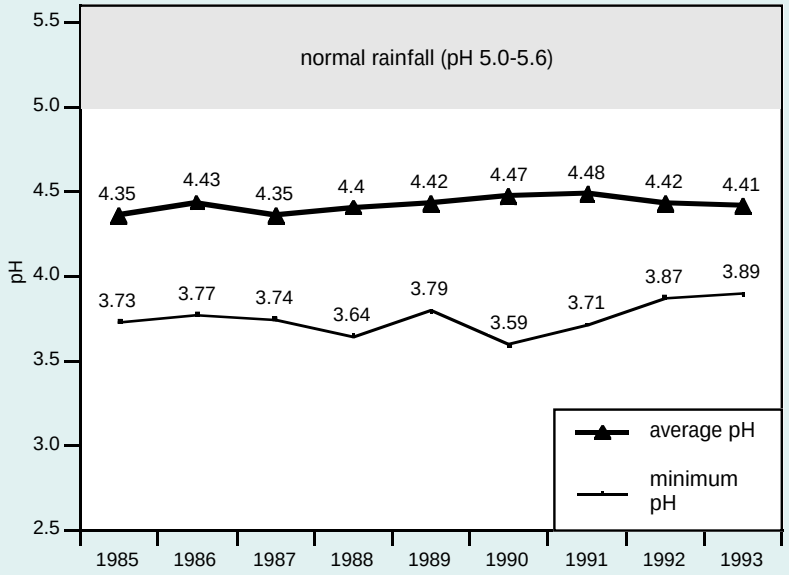


Source: Kentucky Division for Air Quality, 1994

The use of scrubbers, pollution control devices used to remove sulfur dioxide, has assisted in reducing these emissions from coal-fired power plants. The use of scrubbers is expected to increase in Kentucky and the nation as utilities upgrade to meet the requirements of the 1990 Clean Air Act Amendments. The percent of coal burned that is scrubbed has remained fairly constant in recent years. Since 1989, an annual average of 28% of all coal burned was scrubbed at the 21 power plants operating in Kentucky.

Figure 19

Average pH* of Rainfall at Monitored Sites in Kentucky



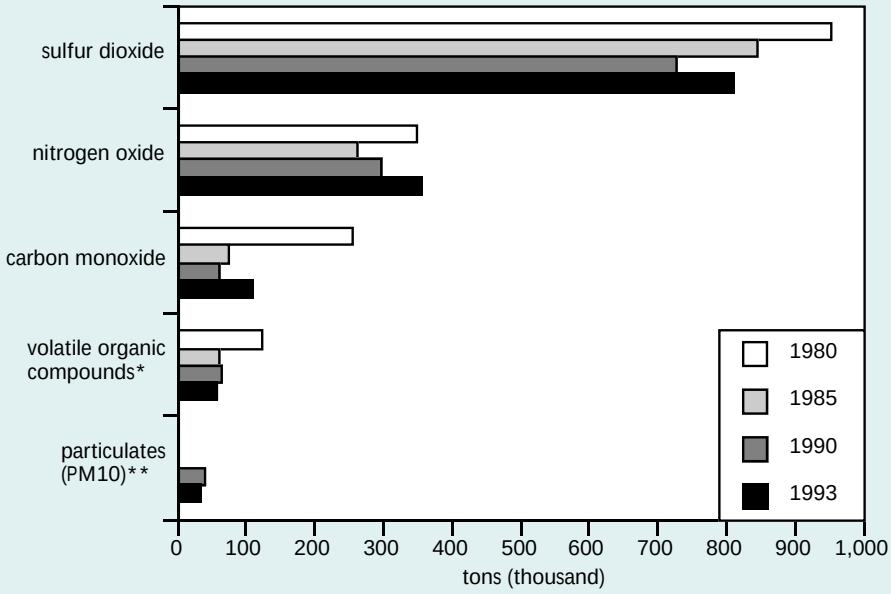
*Note: Data are volume-weighted averages from monitored sites in Washington, Letcher, Rowan, and Trigg counties. *pH is a measure of acidity or alkalinity of a solution.*

Source: National Acid Precipitation Assessment Program, Illinois State Water Survey, 1995.

The acidity of Kentucky's rainfall is monitored at four sites that are part of the National Acid Deposition Program/ National Trends Network. Monitoring at these sites indicates our rainfall has, on average, become slightly less acidic (increasing pH) since the assessment began. National monitoring data show rainfall is acidic throughout much of the Eastern United States. Acid rain is attributed, in part, to emissions of sulfur dioxide and nitrogen oxides emitted from coal-fired power plants, vehicles, factories, and other sources.

Figure 20

Statewide Air Pollutant Emissions from Permitted Sources



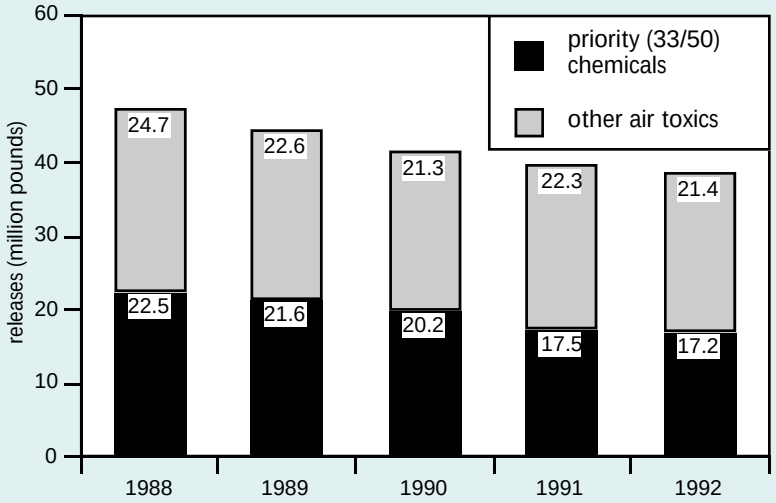
*Note: Data does not include Jefferson County data because the Jefferson County Air Pollution Control District was unable to provide emissions data. *1980 data include total hydrocarbons. **The PM10 standard was established in 1987 for particulates 10 microns in size.*

Source: Kentucky Division for Air Quality, Jefferson County Air Pollution Control District, 1994

Emissions of sulfur dioxide, nitrogen dioxide, and carbon monoxide from permitted industrial sources declined between 1980 and 1985. Emissions generally began increasing for most of these pollutants in 1990 and 1993 due to economic growth and increasing demand for electricity. Electricity is primarily supplied by coal-fired power plants. Reductions achieved in volatile organic chemical emissions are due to regulatory efforts to control ozone (smog) pollution.

II. Air Toxic Indicators

Figure 21
Air Toxics Released from Industrial Facilities in Kentucky



Note: Includes chemicals added to the reportable list in recent years.

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92

During 1992, 39 million pounds of toxic chemicals were directly released to the air in Kentucky. This represents a 18% decrease in toxic air emissions since 1988. Greatest attention has been focused on 17 chemicals prioritized for reduction as part of U.S. EPA's voluntary 33/50 Program.

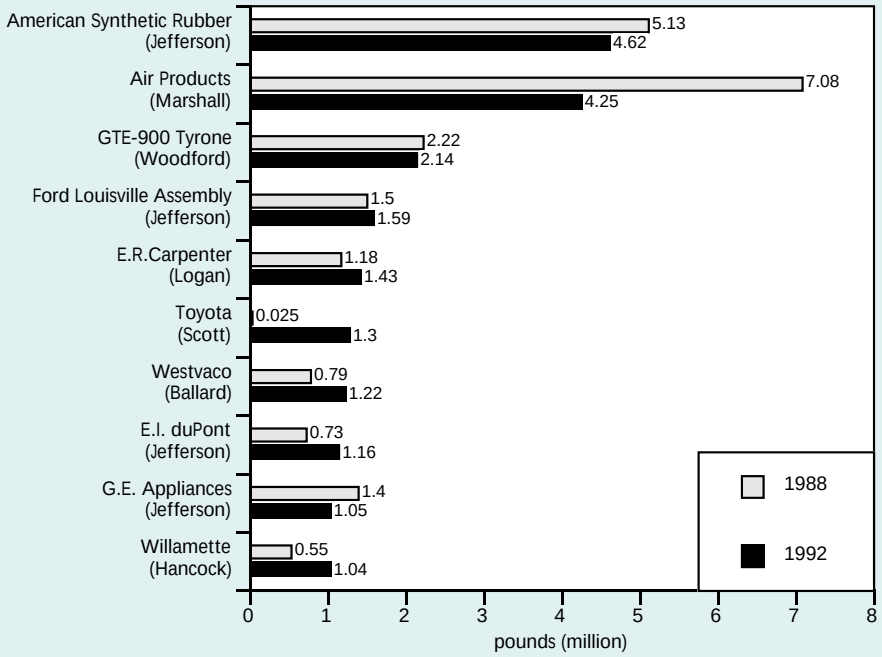
Figure 22
Top Ten Counties with Air Toxic Emissions in Kentucky

County	1988 (pounds)	1992 (pounds)	% Change (1988-1992)
Jefferson	11,924,548	11,410,084	-4.3
Marshall	9,921,245	4,746,016	-52.2
Hancock	3,750,587	2,289,988	-38.9
Woodford	2,350,511	2,209,276	-6
Logan	1,829,826	1,879,545	2.7
Scott	37,016	1,327,124	3,485.3
Ballard	806,350	1,216,895	50.9
Madison	821,367	1,032,668	25.7
McCracken	320,962	887,029	176.4
Hopkins	1,043,246	874,957	-16.1
Total	**32,805,658**	**27,873,582**	**-15.03**
State Total	47,023,709	38,560,031	-18
% State	70	72	

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92

The amount of toxics released to the air varies greatly by county. Changes in industrial activity and new or expanding facilities can affect the amount of toxic releases reported each year. Overall, toxic air releases in the top 10 counties declined 18% between 1988 and 1992. State and federal agencies are increasing efforts to better understand the health and environmental effects of air toxics.

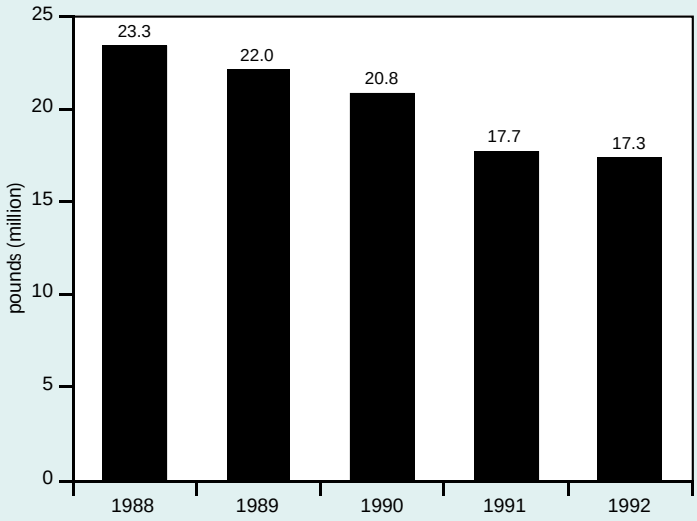
Figure 23
Top Ten Facilities Releasing Air Toxics



Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-94

The majority (55%) of the toxic chemicals released each year into the environment are emitted to the air. Some facilities have made progress in reducing air toxics and other emissions due to voluntary pollution prevention initiatives, regulatory requirements, and other disincentives.

Figure 24
Releases of Priority Toxic Chemicals to the Air in Kentucky



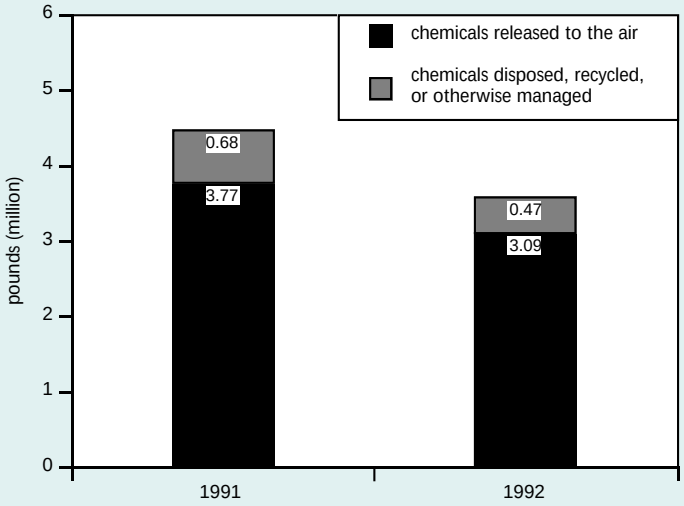
Note: Priority toxics include 17 chemicals the U.S. EPA has prioritized for reduction due to high toxicity, carcinogenicity, or large volume with potential adverse impacts on the environment. U.S. EPA's "33/50" Program encourages industries to voluntarily reduce the total generation of these chemicals 33% by 1992, and 50% by 1995, using 1988 as the baseline.

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-94

Air releases of 17 chemicals prioritized for reductions declined nearly 26% between 1988 and 1992. The decrease is attributed to the voluntary efforts made by numerous industries to reduce these chemicals. Kentucky's "Environmental Leadership Act", passed in 1994, established state goals to further reduce toxic releases from industrial facilities.

III. Ozone Depletion Indicators

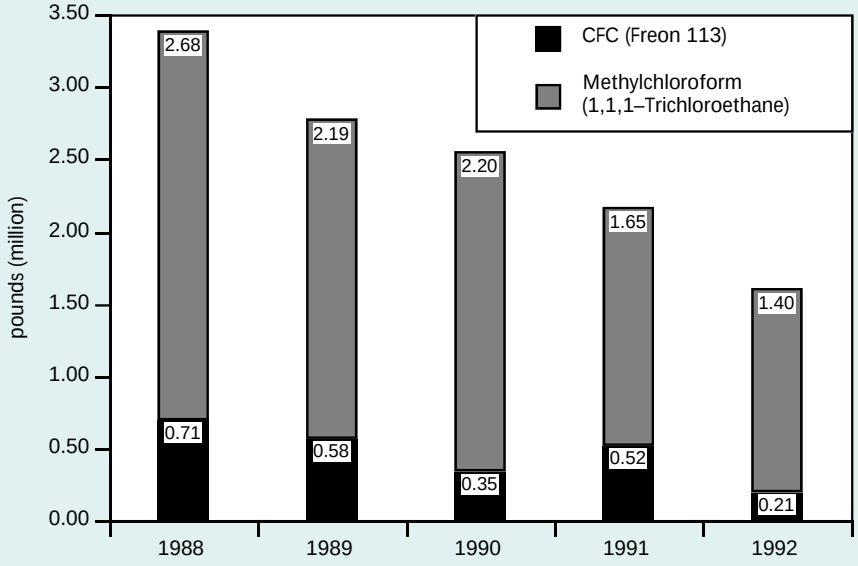
Figure 25
Ozone Depleting Chemicals* Reported by Industrial Facilities in Kentucky



*Includes seven chemicals added to the reportable list in 1991.
Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1991-92

Kentucky industries continue to make progress in reducing generation of chemicals associated with depletion of the ozone layer. Direct air releases of these 11 ozone depleting chemicals, many of which were not required to be reported prior to 1991, declined 18% between 1991 and 1992.

Figure 26
Air Emissions of Selected Ozone Depleting Chemicals from Industrial Sources

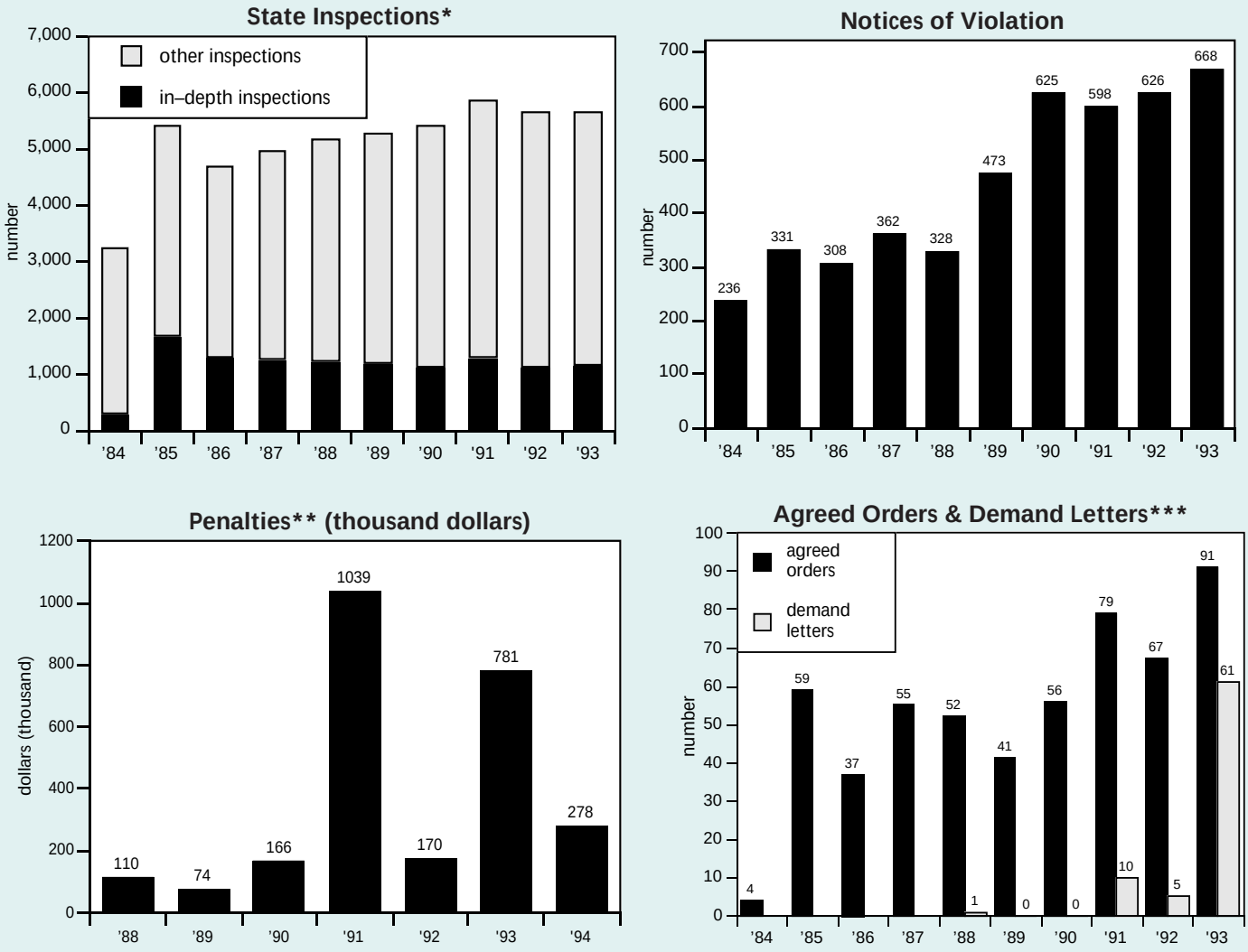


Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92

Industrial releases of CFC's and methyl chloroform, two potent ozone depleting chemicals, continue their declining trends in Kentucky. CFC's are being phased-out as a result of an international agreement that bans production by the year 2000. Methyl chloroform and other ozone depleting chemicals are also targeted for reduction under the 1990 Clean Air Act Amendments. These actions have been necessary because thinning of the ozone layer is considered a serious problem that threatens the global environment and human health.

IV. Enforcement and Compliance Measures

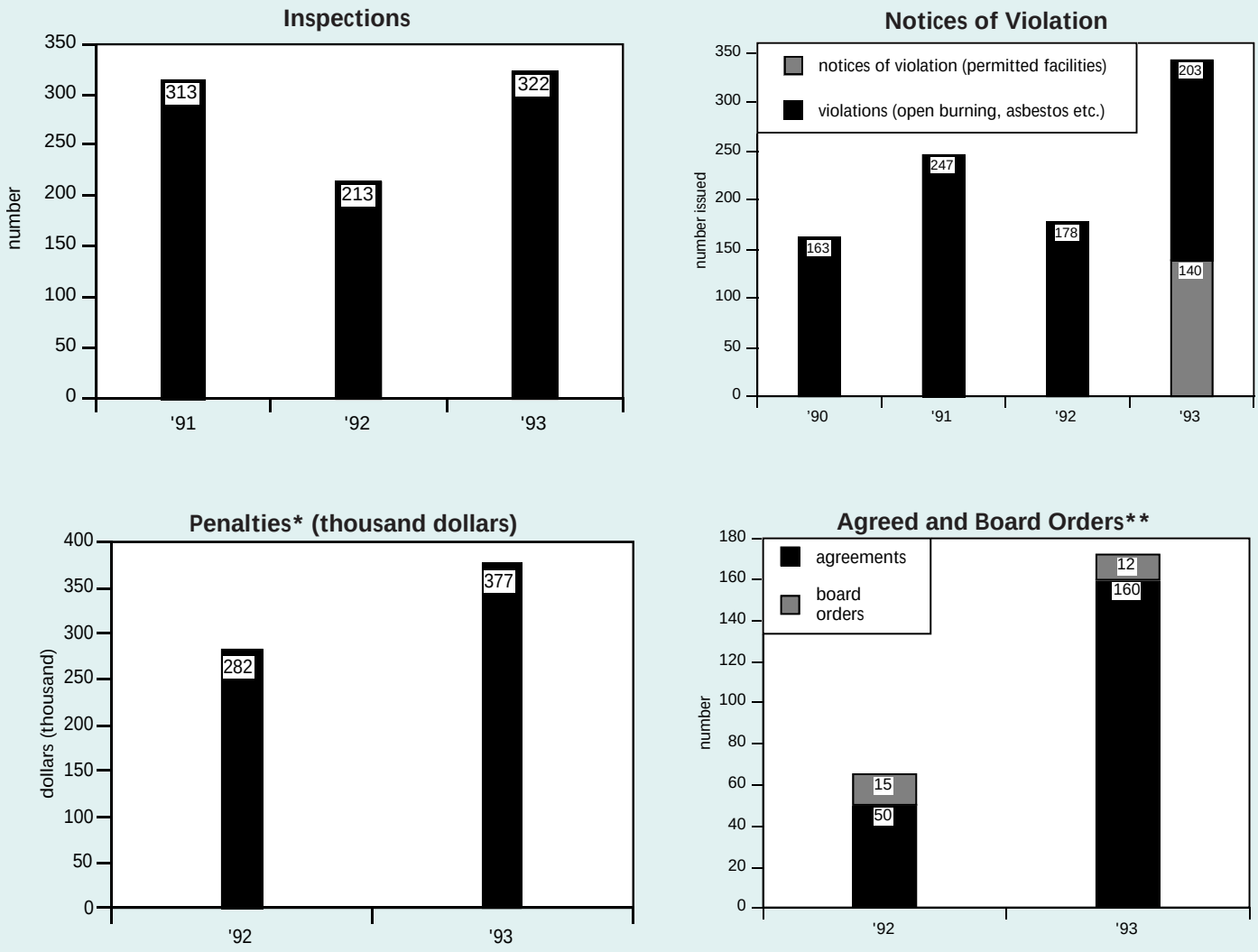
Figure 27
Air Quality Enforcement and Compliance Measures in Kentucky



*Note: Does not include Jefferson County. *In-depth inspections are those scheduled inspections conducted at permitted facilities. Other inspections include those resulting from complaints or other non-routine events. **By fiscal year, includes fines paid and penalties collected from current and previous year cases. * **Agreed orders and demand letters are enforcement tools which outline environmental violations, appropriate remedial measures, and civil penalties. Includes Division for Air Quality and Depatment of Law orders.*
Source: Division of Administrative Services, Kentucky Division for Air Quality, 1995

Enforcement of state air quality laws and regulations involves regular inspection of 3,000 regulated facilities and other pollution sources. The number of inspections has remained fairly constant during the last 10 years, although regulators report inspections are more complex than in earlier years. The number of violations issued due to air quality problems has steadily increased, rising 183% since 1984. This is attributed, in part, to the enforcement of asbestos removal regulations. Penalties for air pollution violations vary greatly from year to year. Substantial penalties were collected during fiscal years 1990-91 and 1992-93, due largely to settlements involving multiple violations at one facility.

Figure 28
Air Quality Enforcement Measures in Jefferson County

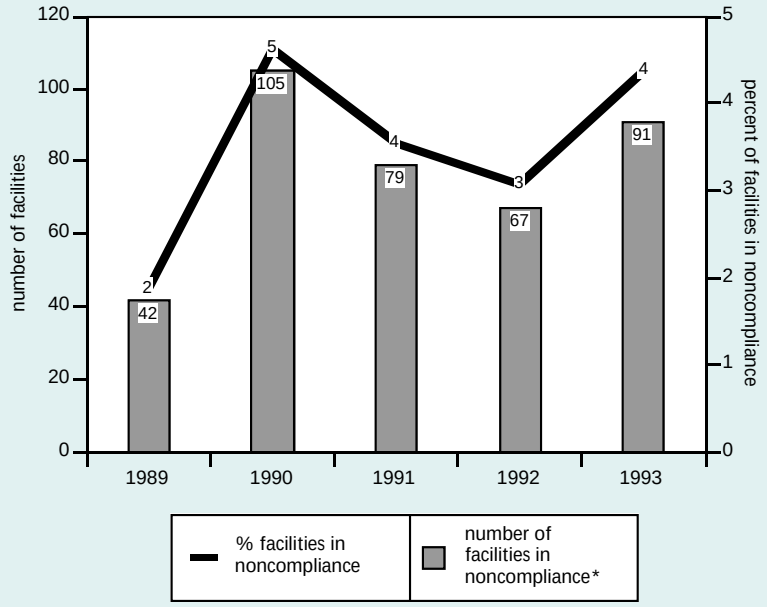


*Note: Earlier violation data unavailable. *Based on penaties collected. **Agreements are entered into with violators that voluntarily agree to remediate problems and pay assessed fines. Board orders mandate actions to remediate air quality problems and are not necessarily the result of agreement over enforcement actions.*

Source: Jefferson County Air Pollution Control District, 1994

The Jefferson County Air Pollution Control District regulates 900 industries and other potential air pollution sources in the Jefferson County/Louisville area. The county was granted regulatory authority by the U.S. EPA in 1970, although it has been responsible for oversight since the late 1940's. The district reports that it has prioritized enforcement activities in recent years due to U.S. EPA emphasis on improving compliance and the need to improve air quality in the Jefferson County. The district also stepped up enforcement to assist facilities in resolving problems before implementation of the 1990 Clean Air Act imposes stricter penalty guidelines for compliance problems.

Figure 29
Number of Facilities in Significant Noncompliance with Air Quality Permits

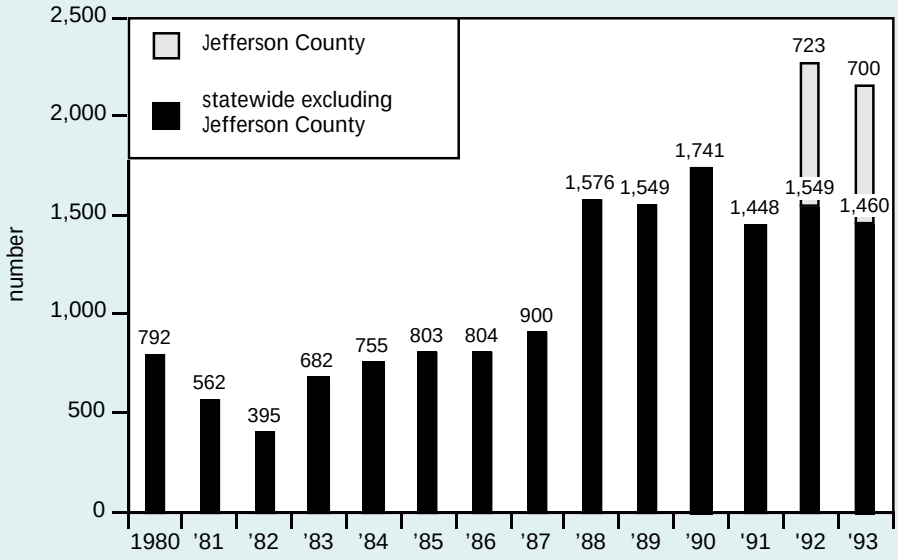


**Significant noncompliance is defined, for this data, as facilities that received a demand letter, entered into an agreed order, received a penalty, or were referred for further action. Does not include Jefferson County.*

Source: Kentucky Division for Air Quality, 1994.

Some facilities experience problems complying with air quality permit requirements and regulations. In 1993, 91 of the 2,075 facilities permitted by the state were under enforcement action due to violations. The Division for Air Quality had 171 open enforcement cases (as of 1/11/95) involving either minor or significant violations. Sixteen cases were referred for formal legal action during 1994.

Figure 30
Number of Complaints Regarding Air Quality in Kentucky



Note: Complaint data for Jefferson County not available for 1980-91.

Source: Kentucky Division for Air Quality, Jefferson County Air Pollution Control District, 1994

The Division for Air Quality and the Jefferson County Air Pollution Control District continue to receive a considerable number of complaints each year regarding air quality. Most complaints relate to odors, dust, and illegal burning. Nearly one-third of the complaints received during 1993 were regarding air quality concerns in Jefferson County.

Chapter 3

Waste Management

Waste Management

The proper management and safe disposal of hazardous, solid, and other wastes provides an important measure of environmental quality. The indicators contained in this chapter track the state's progress in managing the millions of tons of waste generated annually. They include hazardous waste generation trends, treatment and disposal practices, and the status of hazardous waste sites. Indicators also measure solid waste production and disposal, as well as garbage collection and recycling trends. Lastly, generation and disposal trends for medical and low-level radioactive waste provide a general measure of efforts to manage and dispose of these wastes safely.

I. Hazardous Waste

Kentucky continues to make progress in ensuring proper management and disposal of hazardous waste. Hazardous waste is regulated under state and federal law and is defined as waste which poses a substantial present or potential hazard to human health or the environment.

Generation. Each year millions of tons of hazardous waste are generated in Kentucky. In 1993, 6.5 million tons were produced by 471 full quantity generators, defined as industries that produce at least 2,200 pounds of waste a month. Ten facilities accounted for 87.9% of the hazardous waste produced by full quantity generators in 1993. A number of smaller companies (those that produced 200 to 2,200 pounds a month) must also report generation data to the state, however, the quantity produced by these facilities is not considered significant.

Other sources of hazardous waste include those businesses that generate less than 220 pounds of hazardous waste a month and are not required to file reports with the state. Limited quantities of hazardous waste generated by these businesses and households can be disposed at municipal solid waste landfills. The 471 full quantity generators must treat or dispose wastes at permitted hazardous waste facilities.

Treatment. A majority of the hazardous waste produced by full quantity generators is waste is corrosive wastewater or other waste that is treated in a unit on-site, such as a wastewater treatment plant. In 1993, 97% of the hazardous waste produced by full quantity generators was chemically or otherwise treated in this manner. The remaining waste, 207,597 tons, required more sophisticated

Highlights

Hazardous Waste

- During 1993, 471 facilities in Kentucky generated 6.4 million tons of hazardous waste. About 88% of the waste was produced by ten industrial facilities.
- The amount of hazardous waste shipped into Kentucky for treatment or disposal in 1993 increased 38% since 1991 while exports rose 20%.
- 97% of the hazardous waste generated in the state is corrosive wastewater and other wastes that are treated on-site using chemical or physical methods.
- Illegal hazardous waste operations are still a problem with 34 currently under state enforcement action.
- Abandoned hazardous waste sites remain a threat to the environment. To date, 495 of the 894 sites investigated have confirmed contamination and 318 have been cleaned up or are under remediation.

Underground Storage Tanks

- More than 40,000 underground storage tanks have been registered with the state and 15,000 substandard tanks have been removed since 1986. Groundwater or soil contamination problems have been verified at 443 tank sites.

Solid Waste

- During fiscal year 1993-94, 29 municipal solid waste landfills received 3.75 million tons of waste, of which 95% was Kentucky-generated. Most of these landfills are upgrading to meet more stringent plastic and clay liner requirements.
- The amount of out-of-state garbage disposed in Kentucky has declined 74% between fiscal year 1990-91 and 1993-94 due to the closure of landfills, expiration of contracts, increase in disposal fees, and market conditions.
- An estimated 79% of Kentuckians participate in a garbage collection system. All counties now have garbage collection ordinances.
- Recycling opportunities are increasing statewide and 89 counties now have drop-off centers for recyclables.

Medical Waste and Low-Level Radioactive Waste

- Most of the 44 medical waste incinerators in Kentucky are small hospital-operated facilities. Two are commercial medical waste incinerators.
- Disposal restrictions imposed at three out-of-state low-level radioactive waste disposal facilities in 1994 have forced the 404 licensed facilities in Kentucky to store the radioactive waste they generate on-site until the state of Illinois establishes a disposal site.

treatment and was sent off-site to a permitted hazardous waste treatment, storage, or disposal facility. Of the waste sent off-site to a permitted facility in 1993, 11,429 tons was generated from the cleanup of hazardous waste sites.

The amount of Kentucky-generated hazardous waste incinerated in the state has declined significantly, from 92,000 tons in 1989 to 10,000 tons in 1993. This reduction is attributed in part to the increased use of less expensive treatment methods such as fuel blending. There are four hazardous waste incinerators permitted to operate in the state. Three incinerators—Elf Atochem at Calvert City and Carrollton, and Olin Corp. in Meade County—are permitted to burn waste generated by those companies. The only commercial hazardous waste incinerator in Kentucky—LWD Inc. in Calvert City—has been the subject of ongoing controversy during the past several years.

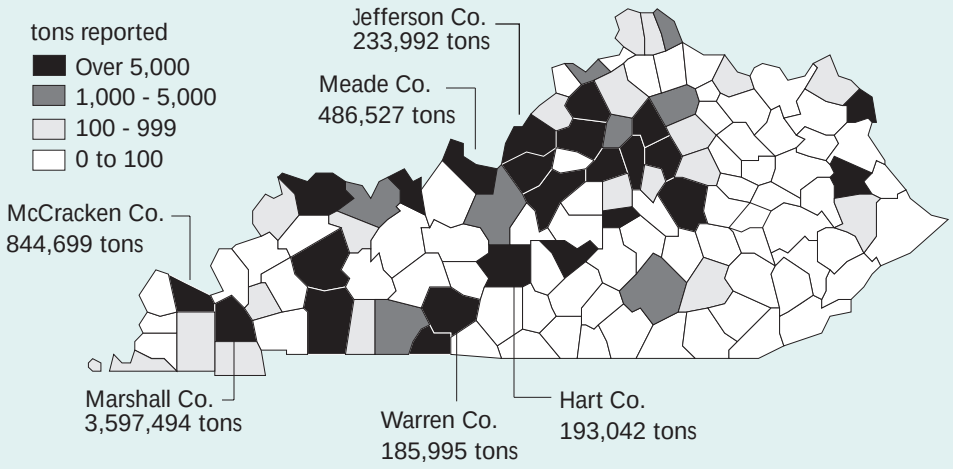
A majority of the hazardous waste incinerated by LWD Inc. is imported from out-of-state. The company reported receiving 34,812 tons of hazardous waste in 1993, compared to 12,850 tons in 1990. The LWD incinerator continues to operate under older federal interim rules. The U.S. EPA is currently evaluating dioxin emissions at the plant.

The U.S. Army's effort to site a nerve gas incinerator in Madison County to burn nerve agents stored at the Lexington-Blue Grass Army Depot continues despite community opposition to the proposal. Those opposed to the incinerator support chemical neutralization as a safer alternative to burning the weapons. The depot holds about 1.6% of the nation's 25,000 ton chemical weapons stockpile. The U.S. Army has proposed building incinerators at nine sites where the chemicals are stored.

Disposal. The amount of hazardous waste generated and disposed in Kentucky has declined over the years. In 1993, very little hazardous waste was actually disposed in the state. This is primarily the result of E.I. duPont finding a market in late 1992 for the 20 to 30 million pounds of hydrochloric acid that it had previously disposed through a permitted underground injection well. In 1993, about two tons of hazardous waste were disposed at Ashland Oil's permitted on-site landfill in Boyd County.

Hazardous waste generated in Kentucky is increasingly being shipped out-of-state for treatment, storage, or disposal. The amount of waste sent out-of-state almost doubled between the years 1987 and 1993. Likewise, the amount of hazardous waste shipped into Kentucky is increasing after a four year decline between 1988 and 1991. In 1993, 162,000 tons of hazardous waste were shipped out-of-state while 124,000 tons of waste were imported into Kentucky for treatment. A majority of the waste sent to Kentucky, 90%, was received by three permitted treatment facilities—Safety Kleen in New Castle, LWD in Calvert City, and Midwest Environmental Services in Louisville. The state is currently updating its capacity assurance plan, required under federal law, to assure the

Hazardous Waste Generation and Top Producing Counties in Kentucky (1993)



Source: Kentucky Division of Waste Management, 1994

state has adequate ability to treat and dispose Kentucky-generated hazardous waste.

The diversion of household hazardous wastes such as paints, solvents, and pesticides from municipal solid waste landfills continues in some areas of the state. Louisville and Jefferson County, in cooperation with various companies, government agencies, and volunteers, held six household hazardous waste collection days in 1993 and 1994. In 1993, 7,600 households participated in the Jefferson County program and 40 tons of material, primarily oil, antifreeze, and batteries was collected and properly treated, recycled, or disposed.

Scott County, with the assistance of Toyota, has held household hazardous waste collection days during recent years. In 1994, the program collected 23,108 pounds of waste. Other communities have sponsored programs for the collection of certain household waste, such as paint, for reuse. Boone County Public Works Department accepts used antifreeze for recycling.

Enforcement. The Division of Waste Management continues to identify illegal hazardous waste operations. In 1993, 34 illegal operations were under enforcement action for failing to notify the state of their operations or activities as required under law. Enforcement of hazardous waste rules resulted in a record number of violations in 1992 as well. Groundwater monitoring at hazardous waste treatment, storage, and disposal facilities also detected contamination at 13 permitted facilities and another 31 non-permitted sites.

Waste Sites. The environmental and financial impact of past waste management practices grows with the discovery of more contaminated waste sites each year. More than 1,000 potential abandoned sites have been identified. Of the 894 sites investigated, 495 had contamination problems detected.

Two hundred contaminated sites have been, or are being, addressed by those parties responsible for disposing the waste. Another 85 sites have been contained and 13 are being cleaned up with state monies provided through the Hazardous Waste Management Fund. These funds are used when responsible parties cannot be identified or are not financially able to clean up the site. The Fund is financed by a fee assessed on companies that generate hazardous wastes.

Twenty of the federal National Priority List Superfund sites located in Kentucky are in various stages of remediation. Five are regarded by the U.S. EPA as clean enough to be considered for removal from the National Priority List of nation's worst waste sites which now include 1,242 sites.

II. Underground Storage Tanks

Kentucky has made significant progress in addressing leaking underground storage tanks. Since 1986, nearly 40,000 tanks have been registered with the state and 15,000 have been removed or closed to prevent groundwater and soil contamination.

Contaminated Tank Sites. Contamination problems have been discovered at 414 tank sites during the past eight years. The cleanup costs have been significant, ranging from an average of $25,000 for a site with relatively little contamination, to $100,000 for one that has soil and groundwater contamination.

A 1991 state law was amended in 1994 to help raise additional funds to pay for the cleanup of contaminated tank sites. The law provides for a one cent fee on each gallon of gasoline sold in the state. The fee is used as an insurance fund to assist service station owners and others who cannot afford to clean up contaminated sites. As of November 1994, $47 million had been obligated to 683 applicants. Ninety sites have been fully cleaned up and closed with the assistance of the Underground Storage Tank Fund.

The high costs associated with tank cleanups led the Kentucky General Assembly to pass a law in 1992, and amend it in 1994, requiring the development of new risk-based standards pertaining to the cleanup of waste oil, lead, gasoline, diesel, and new oil at contaminated tank sites. The standards are expected to be in place in mid 1995.

The task of processing tank closures remains a significant state challenge. More than 2,000 tank closure plans have been processed and 2,800 await review by the Division of Waste Management.

III. Solid Waste

The management of solid waste remains a top environmental priority in Kentucky. Regulatory reforms passed in 1990 and 1991 have led to the closure of a number of substandard landfills, new landfill construction and monitoring requirements, and an emphasis on long-range solid waste planning and waste reduction.

Generation. Reports reveal that, from July 1, 1993 through June 30, 1994, 3.75 million tons of household, commercial, yard, and industrial solid waste was disposed at the 29 municipal solid waste landfills operating in the state. According to these reports, 95% of the waste disposed at these landfills was Kentucky-generated and 5% was imported from out-of-state. The waste stream shipped into Kentucky for disposal has declined 74% between fiscal year 1990-91(756,000 tons) and 1993-94 (192,750 tons) primarily due to the closure of 47 substandard landfills, expiration of contracts, market conditions, and an increase in landfill tipping (disposal) fees. Levels did, however, double between 1992-93 (97,546 tons) and 1993-94.

Disposal. Many of the 29 active municipal waste landfills are undergoing transition to meet more stringent state and federal rules. Six landfills currently meet the

1995 state requirement for a clay and plastic liner and 19 others have filed permits to upgrade to meet the new standards. Another five permits for new municipal landfills have been proposed.

All counties now have long-range plans to assure future solid waste disposal needs. A review of existing and proposed capacity, however, reveals that landfills are currently more concentrated in some regions of the state than others. Therefore, some wastes must move greater distances to those areas with adequate landfill space. State officials predict that landfill capacity will continue to balance out as regional landfills are permitted and disposal contracts are entered into between counties and landfills. One company proposing to site a landfill in Kentucky has recently challenged the state law regarding solid waste planning alleging it violates the U.S. interstate commerce rules.

There are other facilities that also dispose, receive, or process various types of waste. They include 36 residual landfills that dispose industrial sources of solid waste, 56 landfarm operations which dispose sludge through land spreading, and three special waste landfills that receive high volume but low hazard waste. The number of construction and demolition debris (CDD) landfills has increased the greatest, from three in 1993 to 52 in 1994, primarily in response to the increased cost of disposing this waste at municipal landfills.

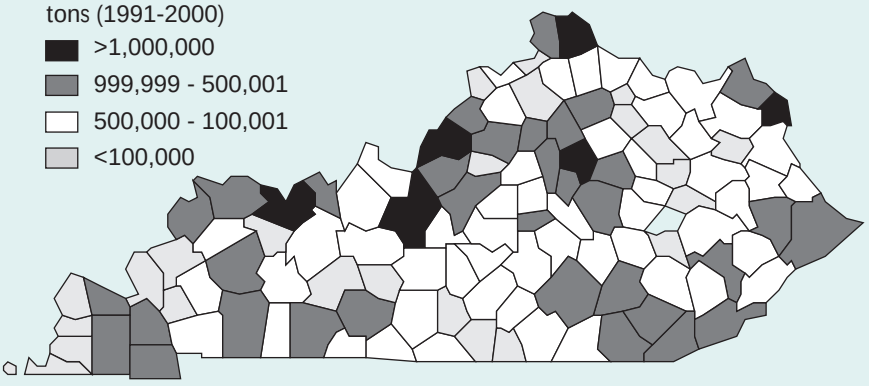
Municipal landfill disposal fees have increased from an average of $18 in 1991, to $23.68 per ton in 1993 due to costs of meeting stricter federal and state construction and operating standards. But these fees are still well below the average national disposal fee of $36 a ton.

It is expected that the number of special waste landfills will also increase as coal-fired power plants and other sources of low hazard but high volume wastes come under increased regulatory scrutiny and control. The Division of Waste Management recently permitted a special waste landfill in Floyd County to dispose fly ash generated by a power plant located in Florida.

Garbage Collection. All 120 Kentucky counties have adopted solid waste collection ordinances compared to just 14 in 1991. The average cost per household for garbage collection increased from $4 to $6 a month in 1991, to $7 to $14 a month in 1994.

Only 20 county garbage collection ordinances require mandatory participation. The remainder are voluntary in nature. While it is difficult to accurately assess how many Kentuckians participate in garbage collection. County solid waste reports submitted for 1993 indicate that an estimated 79% of Kentucky households are served by a garbage collection system. Currently, 115 counties offer door-to-door garbage collection. The remainder use

Municipal Solid Waste Generation in Kentucky*



**Based on municipal solid waste generation for a ten year period (1991-2000) as estimated in county solid waste plans.*

Source: Kentucky Division of Waste Management, 1994

convenience centers or unstaffed collection boxes.

Open Dumping. An estimated 21% of the household solid waste generated in Kentucky is still illegally disposed. Local governments are required to identify and schedule the cleanup of open dumps. To date 3,746 open dumps have been identified and 1,156 have been cleaned up.

Waste tire piles continue to pose environmental and public health problems as well. More than 10 million waste tires are stockpiled or illegally disposed in Kentucky. Another 3.8 million waste tires are generated annually of which an estimated 10% are recycled, recapped, or sold as spares. The recent discovery of the Asian Tiger mosquito, a vector of human and equine encephalitis, breeding in waste tire piles in 59 counties has led the state to take further action to clean up tire dumps.

A 1991 state law imposing a $1 disposal fee on all new tires sold was amended in 1994 to restrict fee exemptions to reclaimed tires in order to promote reuse and raise the needed funds to clean up waste tire piles. To, date the Waste Tire Trust Fund has collected $2.9 million. Grants totaling $1.8 million, and $200,000 in loans, have been allocated under the trust fund. A second cycle of grants is planned. A strategy to further address waste tires is currently under development by the Division of Waste Management.

Recycling. According to the U.S. Environmental Protection Agency, about 15% to 20% of the municipal solid waste stream generated nationwide was recycled in 1992. It cannot be accurately determined how much waste is recycled in Kentucky because facilities that process recycled materials are not now required to register with or report to the Division of Waste Management. The division is charged with measuring the 1997 statewide goal to reduce per capita generation of solid waste 25%.

Progress in reducing solid waste is being made as markets for recyclables improve and more Kentuckians are provided access to recycling programs. Most counties are now within reach of a recycling operation. There are currently 179 commercial recycling facilities, 263 used oil collection centers, 34 tire collection centers, and three waste tire recyclers operating in the state.

Eighty-nine counties now have drop-off centers for recyclables. Door-to-door collection of recyclables is currently limited to more populated areas such as Lexington and Louisville. In 1993, the City of Louisville's curbside program collected 9,500 tons of recyclables, about 12% of the waste stream in those participating areas. Lexington annually collects 4,000 tons from curbside recycling, about 10% of the waste stream in participating areas. The city is also in the process of implementing a pilot recycling program in schools and businesses.

The potential for recycling and waste reduction in the private sector is considerable. Some industries have initiated programs aimed at reducing and recycling solid wastes. In 1992 the E.I. duPont, Louisville Works facility succeeded in reducing the amount of solid waste sent off-site 22%, compared to 1991 figures. An incentive program rewarded employees with a $50 U.S. Saving Bond by helping the plant achieve this reduction in trash, waste product, and solids in the wastewater. The company realized a net savings of $75,000 after paying for the savings bonds.

Sunoco, in Henderson County, recycles four types of paper, aluminum cans, and at least 75% of the company's employees drop their empty payroll envelopes into a collection box for reuse on another payday. The company has also reduced the amount of solid waste going to the landfill by 79% since 1991. All scrap generated by the company and all incoming packaging are either recycled or reused in some way. These and other actions have generated an annual cost saving of $850,940.

The cost associated with promoting recycling markets and developing the infrastructure necessary to process materials is significant. State officials estimate that, during the next three to four years, $8 million is needed to develop regional recycling facilities to more efficiently collect and process materials.

One regional recycling facility has been established in Western Kentucky. The Regional Recycling Corporation is governed by a board of directors and each county contributes $10,000 to join. Since its start-up, the Regional Recycling Corporation processed 1.3 million pounds of materials from seven counties saving $8,000 in landfill disposal fees between March and November 1994.

Another $7 million is needed to develop and promote markets for recyclables, according to state economic development officials. Various funding proposals such as container deposit fees, landfill tonnage surcharges, and advance disposal fees have been considered to help raise the necessary funds to promote recycling markets and infrastructure but have not yet been approved by state lawmakers.

Enforcement. Enforcement of Kentucky's new solid waste regulations led to a record number of violations in 1992 and record penalties in 1993. Citizen complaints have also increased as the public becomes more aware of waste problems and involved in cleaning up open dumps in their communities. Seventy-five counties have hired solid waste coordinators to promote recycling and other waste programs at the local level.

III. Medical and Low-Level Radioactive Waste

Medical Waste. Most medical waste generated in Kentucky is disposed in municipal solid waste landfills. However, "red bag" medical waste, which includes blood and other infectious materials, must be autoclaved or incinerated to render it nonhazardous.

New state rules to better regulate the air emissions associated with burning medical waste at incinerators took effect in December 31, 1994. Forty-four medical waste incinerators are currently permitted in the state, a majority of which are small hospital-operated incinerators. There are two medical waste incinerators in the state not operated by hospitals—Medisin in Floyd County and BFI in Jefferson County. The Division for Air Quality is presently determining compliance of medical waste incinerators with the new emission requirements.

Low-Level Radioactive Wastes. The Department of Health's Radiation Control Branch currently licenses 404 facilities to receive, handle, and dispose low-level radioactive waste. Licensed facilities, which include universities, hospitals, and biotech companies, generated 800 cubic feet of low-level radioactive waste during 1993.

In the past, low-level radioactive waste generated by licensed facilities has been disposed out-of-state at three sites located in Nevada, Washington, and South Carolina. However, disposal of low-level radioactive waste at these sites is now limited to only those states where regional agreements exist.

Kentucky, along with 30 other states, is currently without a disposal site for its low-level radioactive wastes. The Commonwealth does have an agreement with the state of Illinois to dispose of its low-level radioactive waste. But after several years, Illinois has yet to site a disposal facility. In the meantime, Kentucky generators are now forced to store the waste on-site.

The largest generator of low-level radioactive waste is the U.S. Enrichment Corporation's Gaseous Diffusion Plant in Paducah. The plant enriches uranium for use as fuel in commercial nuclear reactors and nuclear vessels. In 1993, 11,000 cubic feet of low-level radioactive waste was generated by the facility, a decline from 1991 when 66,300 cubic feet were produced. Almost all the low-level radioactive waste generated at the plant is stored on-site.

Radioactive contamination was discovered in water wells near the site in 1988. Since then, $166 million have been spent to study environmental problems at the Gaseous Diffusion site. Remediation efforts are focused on controlling the spread of a vast plume of groundwater contaminated by radioactivity and organic chemicals which has moved three miles from the site and is now within a few hundred feet of the Ohio River.

Kentucky's other waste site with radioactive contamination—the Maxey Flats low-level radioactive waste site in Flemingsburg—is listed as a federal superfund site. Maxey Flats received six million cubic feet of low-level radioactive waste during its operation from 1963 to 1977. The state assumed ownership of the site in 1978 after groundwater contamination was discovered leaking from the 52 burial trenches.

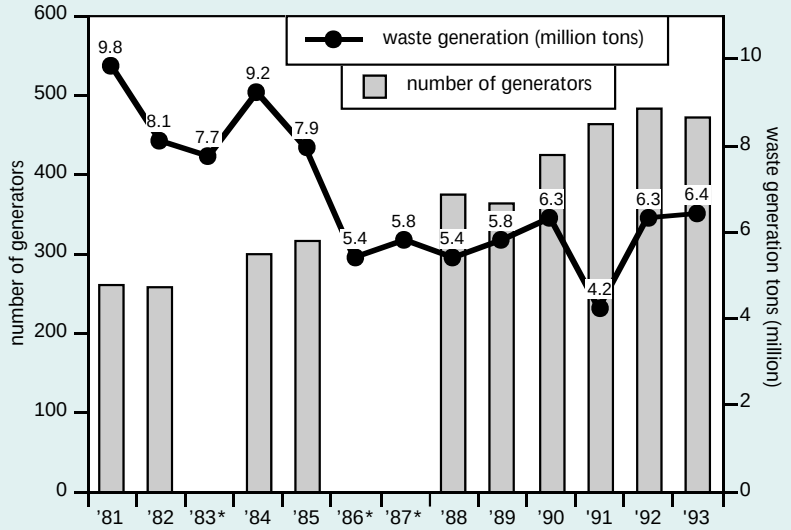
The Maxey Flats site was placed on the federal superfund list of the nation's worst waste sites in 1986. Containing the spread of contamination will cost $34 million and includes installing a cap over the perimeter of the disposal area and long-term monitoring. However, remediation actions have been stalled during the last two years as state officials and over 800 other responsible parties negotiate an agreement outlining financial obligations for cleaning up the site.

Of more recent concern has been the discovery of naturally occurring radioactive materials (NORM) at oil fields in Kentucky. NORM occurs naturally underground but was brought to the surface when water was used in the mid 20th century to force oil out of wells. High levels of NORM have been detected at oil pits in Johnson and Lawrence counties. A year-long project was undertaken in the spring of 1994 by the Department of Health Services to test sites in the Martha Oil Field for contamination. Of the sites screened to date, 23% have radium levels above those naturally occurring in the soil. The department is also developing standards for the cleanup and disposal of NORM waste.■

I. Hazardous Waste Indicators

Figure 1

Hazardous Waste Generation Trends in Kentucky

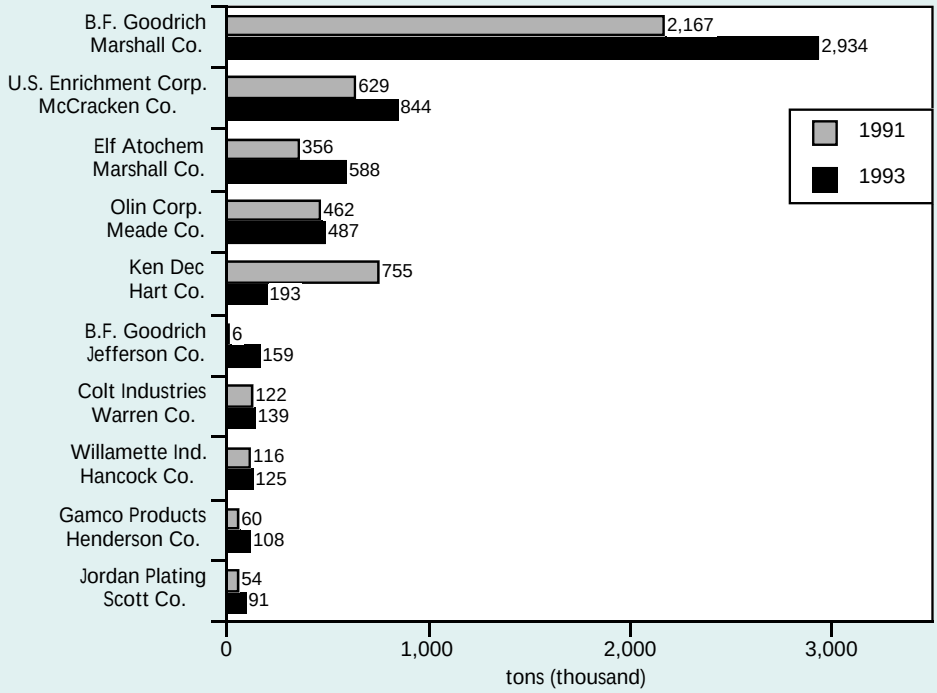


*Note: As reported by full quantity hazardous waste generators registered with the state. These facilities are defined as producing 2,200 pounds or more of hazardous waste per month *Data for number of generators unavailable for these years. Source: Kentucky Division of Waste Management, 1994.*

While the number of full quantity hazardous waste generators has steadily increased, the amount of hazardous waste generated each year in Kentucky has remained fairly constant since 1986, with the exception of 1991. The drop during 1991 was attributed to the redesignation of calcium sulfate from a hazardous waste to a by-product at the Elf Atochem plant in Marshall County

Figure 2

Top Ten Hazardous Waste Generators in Kentucky (1993)

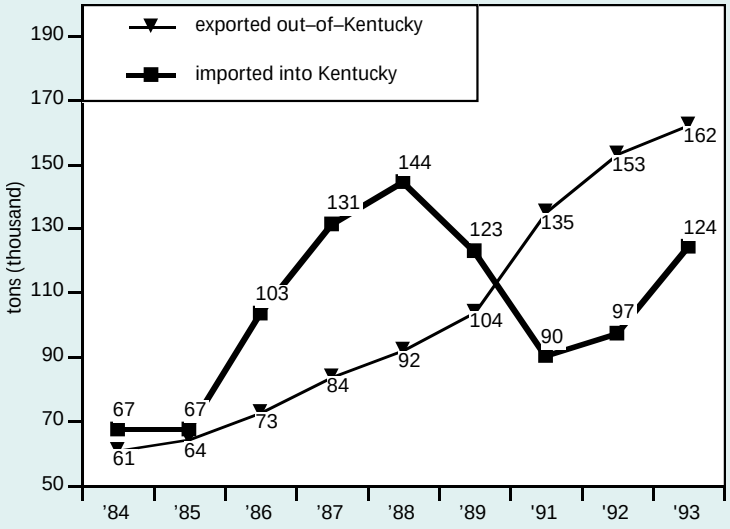


Source: Kentucky Division of Waste Management, 1994.

In 1993, 416 of the 471 major hazardous waste generators in the state produced less than 1,000 tons of waste. A majority of the hazardous waste reported generated, about 88%, was produced by ten facilities in nine counties. The state passed the Environmental Leadership Act in 1994 to promote a 25% reduction of hazardous waste generated at these and other facilities by 1997 and 50% by 2002.

Figure 3

Hazardous Waste Imported Into and Exported Out of Kentucky



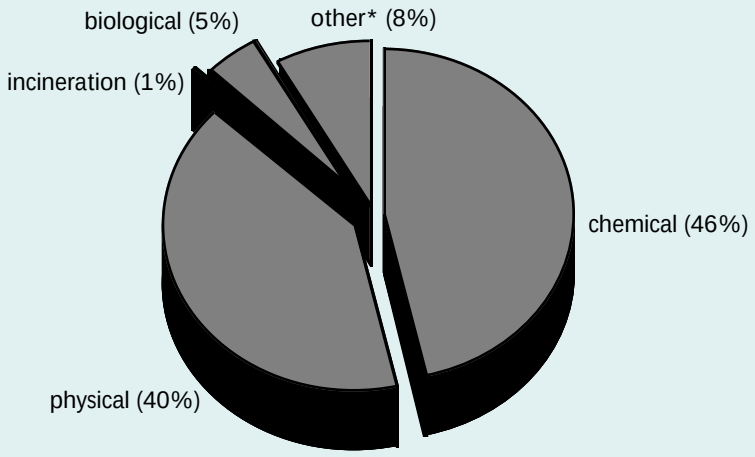
Note: Data for 1990 not available.

Source: Kentucky Division of Waste Management, 1994.

Kentucky industries are increasingly exporting hazardous waste out-of-state for treatment, storage, or disposal. During 1993, 162,000 tons of Kentucky-generated hazardous waste was sent to 29 other states. The amount of hazardous waste imported into the state is on the upswing as well. During 1993, 124,000 tons of hazardous waste were imported into Kentucky by 46 states and two territories for treatment. About 90% of the hazardous waste imported was shipped to Safety Kleen in Henry County, LWD in Marshall County, and Midwest Environmental Services in Jefferson County.

Figure 4

Hazardous Waste Treatment Technologies Used in Kentucky (1993)



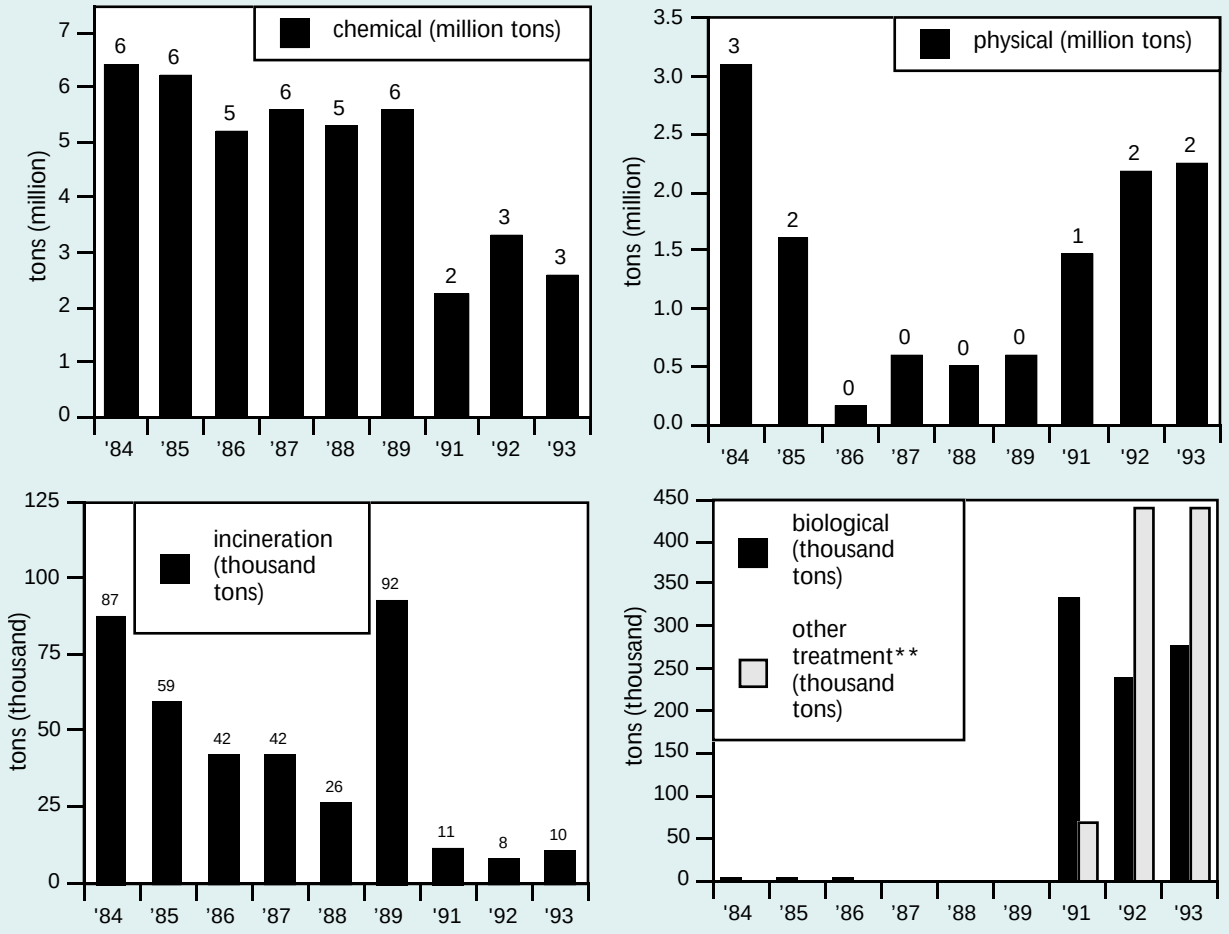
**Other includes metal recovery for reuse, energy recovery, aqueous organic and inorganic treatment, and other treatments.*

Source: Kentucky Division of Waste Management, 1994.

Much of the hazardous waste generated in Kentucky, about 97% in 1993, is corrosive wastewater and other wastes that are neutralized with chemical or other treatment methods at on-site facilities such as wastewater treatment plants. The remaining waste requires more sophisticated treatment because it is of a greater hazard. This waste was sent off-site to a permitted hazardous waste treatment, storage, or disposal facility.

Figure 5

Hazardous Waste Treatment Trends in Kentucky*



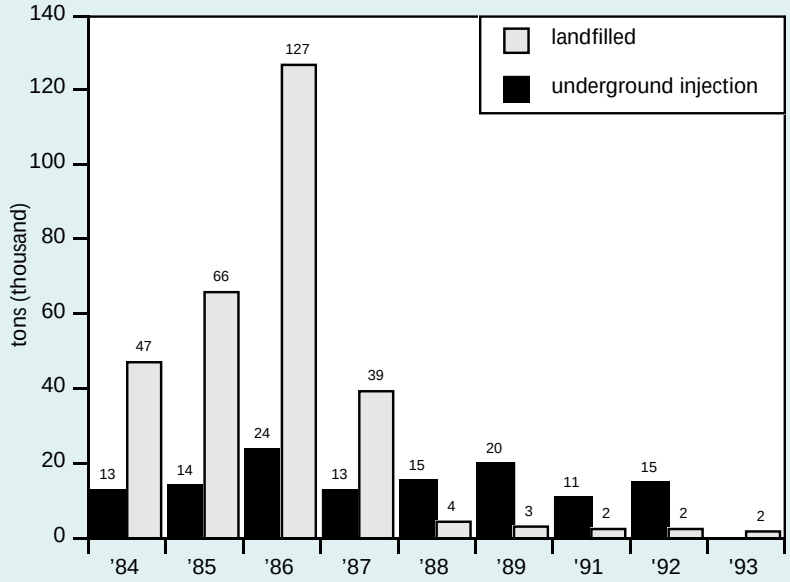
*Note: Data for 1990 not available due to technical problems. Data rounded. *Includes only Kentucky-generated hazardous waste treated in the state. Waste shipped into Kentucky for treatment not included. **Other treatment includes metal recovery for reuse, energy recovery, aqueous organic and inorganic treatment, and other treatments.*

Source: Kentucky Division of Waste Management, 1994.

Physical treatment of hazardous waste generated in Kentucky is increasing while incineration is declining. The shift toward more physical treatment, which includes distillation, fuel blending, and sedimentation, reflects the growing trend by generators to minimize treatment or disposal costs. The market for blended waste fuel is also increasing. Currently, there are two facilities permitted in Kentucky to burn blended waste for energy. Kentucky's only commercial incinerator, LWD Inc. in Calvert City, continues to operate under interim status. Three other industrial hazardous waste incinerators are permitted to only burn wastes generated by their companies.

Figure 6

Hazardous Waste Disposal Trends in Kentucky

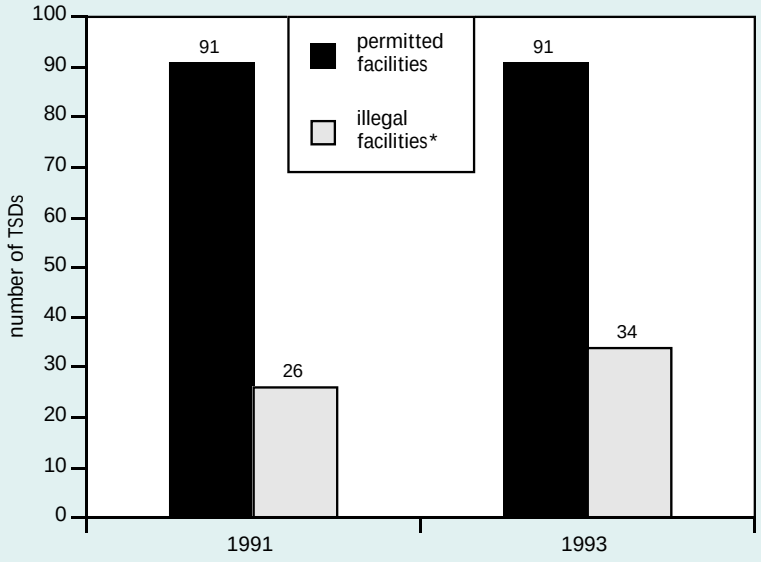


Note: Only includes disposal of Kentucky-generated waste. Data for 1990 not available due to technical problems. Source: Kentucky Division of Waste Management, 1994.

The amount of waste disposed through deep well injection declined to zero in 1993. The reduction is the result of E.I. duPont finding a market for the hydrochloric acid created during their chemical manufacturing process. The landfilling of hazardous waste has also declined due to the closure of all but one permitted hazardous waste landfill in the state. Ashland Oil, in Boyd County, operates the only active hazardous waste landfill in the state.

Figure 7

Permitted and Illegal Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities in Kentucky

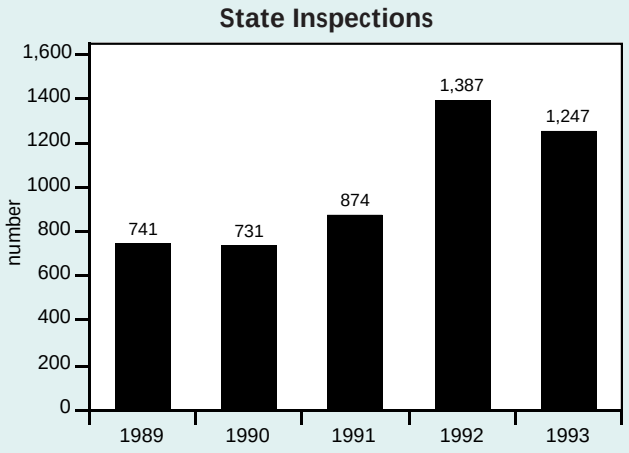


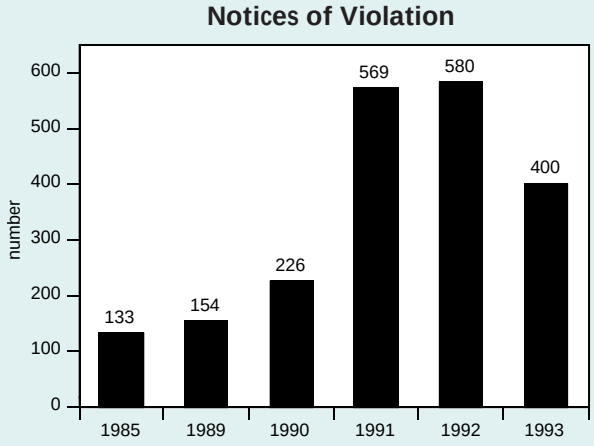
**Illegal hazardous waste facilities under enforcement action include those that fail to notify the Kentucky Division of Waste Management of their operation or activity. Source: Kentucky Division of Waste Management, 1994.*

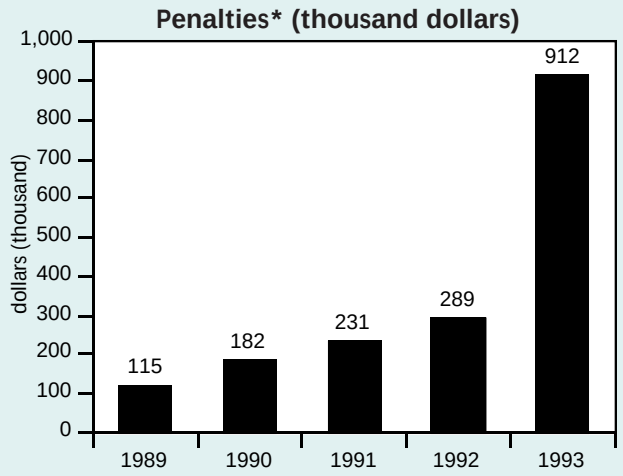
There are 91 facilities in Kentucky permitted to treat, store, and dispose hazardous waste. During the last several years, the Division of Waste Management has focused its efforts on identifying illegal hazardous waste facilities that have failed to notify the state of their operations or activities. In 1993, 34 illegal hazardous waste operations were under enforcement action to bring them into compliance.

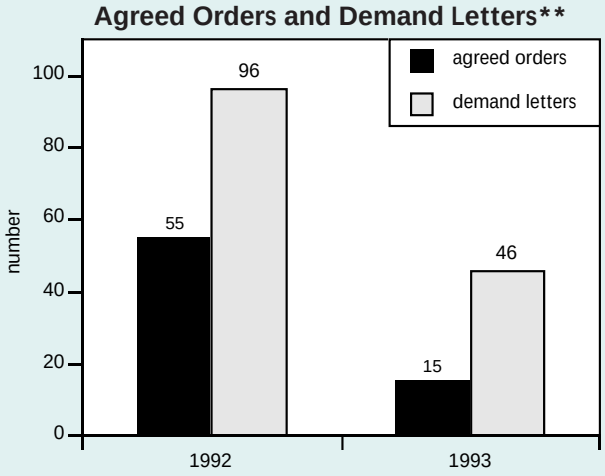
Figure 8

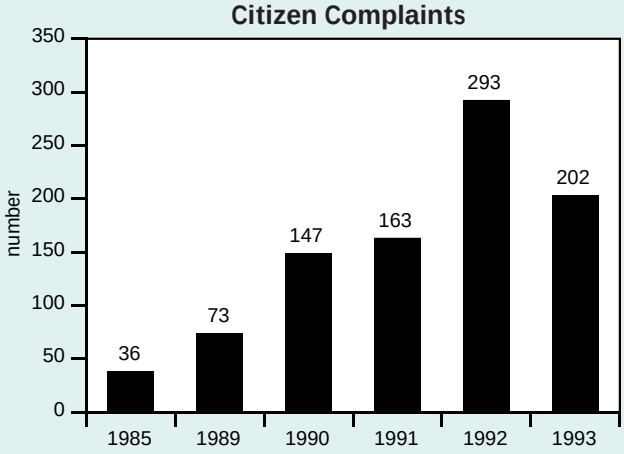
Hazardous Waste Enforcement and Compliance Measures









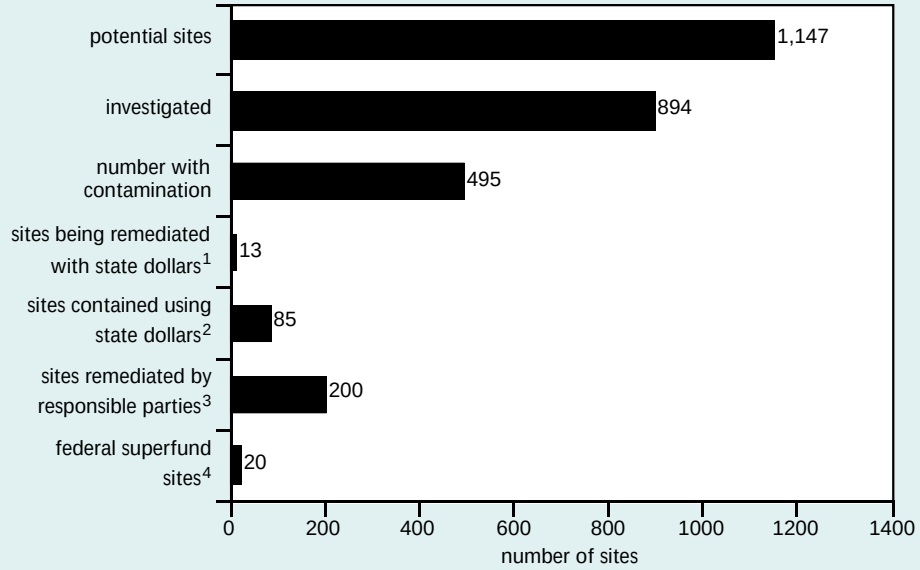


*By fiscal year, includes fines paid and penalties collected from current and previous year cases. **Agreed orders and demand letters are enforcement tools used to outline environmental violations, appropriate remedial measures, and civil penalties.
Source: Kentucky Division of Waste Management, 1994

The enforcement of waste laws and regulations during the past few years has resulted in a record number of violations in 1992. Currently, 67 of the 91 permitted hazardous waste treatment, storage, and disposal facilities are under enforcement action to correct violations. Corrective actions are also underway at 13 permitted and 31 non-permitted sites to address groundwater contamination problems. The state collected a record amount of penalties for hazardous waste violations in 1993. However, large penalties settled against three companies accounted for 92% of the $912,000 collected that year.

Figure 9

Status of Abandoned Contamined Sites* in Kentucky

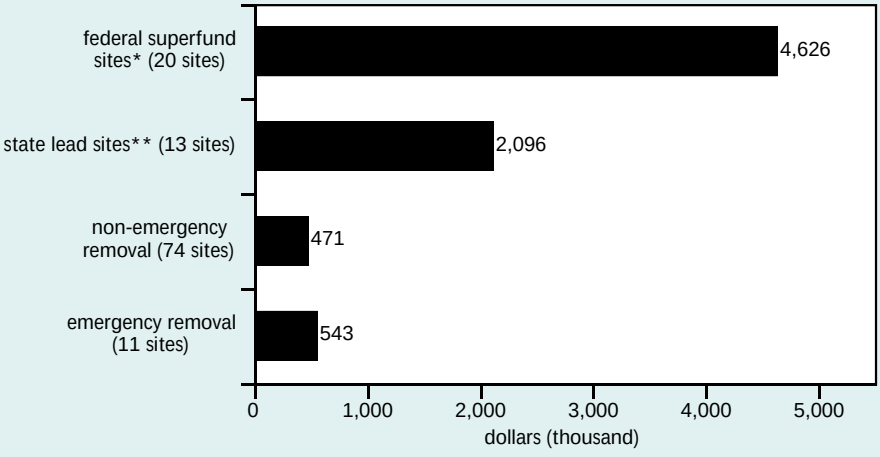


**Sites with suspected releases of a hazardous substance, pollutant, or contaminant. [1]Priority hazardous waste sites where responsible party cannot be found or cannot pay for cleanup. Cleanups financed by state Hazardous Waste Management Fund. [2]Hazardous waste sites where state Hazardous Waste Management Funds were used for emergency and nonemergency actions. [3]Potential responsible parties who disposed wastes at the site and have been required to finance the cleanup of the site. [4]Federal superfund sites (National Priority List sites) where investigations and cleanups are supervised by the U.S. EPA.*
Source: Kentucky Division of Waste Management, 1994.

To date, 55% of the 894 suspected contaminated sites investigated had varying levels of contamination. The state continues to identify, prioritize, and cleanup contaminated sites based on risks to public health and the environment.

Figure 10

Expenditures From State Hazardous Waste Management Fund



*Note: Hazardous Waste Management Fund balance $1.7 million as of Oct. 1994. *Funds set aside as required as a state match to cleanup the 20 federal superfund sites in Kentucky. **State lead sites are those sites that have no responsible party and do not qualify for federal superfund dollars. These 13 sites are being cleaned up with state Hazardous Waste Management Fund dollars.*
Source: Kentucky Division of Waste Management, 1994

The state Hazardous Waste Management Fund, financed through an assessment on the generation of hazardous waste, currently raises about $2.2 million a year to clean up contaminated sites. A portion of the fund has been set for the cleanup of 20 federal National Priority List Superfund sites located in the state. The fund has also been used to address problems at 98 other sites where emergency actions were needed or a responsible party could not be found or was financially unable to cleanup the site.

Figure 11

Status of National Priority List Federal Superfund Sites in Kentucky

Site	Status	Listed	Respons. Party
A.L. Taylor- Valley of Drums Brooks–Bullitt Co.	Cleanup complete. Operation and maintenance phase.	1981	Yes
B.F. Goodrich/Airco (2 sites) Calvert City–Marshall Co.	Settlement reached between U.S. EPA and state. Now in remedial design stage.	1982	Yes
Brantley Landfill Island–McLean Co.	Cleanup studies concluded. Remedial design phase to begin in 1995.	1990	Yes
Caldwell Lace & Leather Auburn–Logan Co.	Cleanup studies concluded. U.S. EPA determined no action is necessary.	1990	No
Distler Brickyard West Point–Hardin Co.	Remedial design underway. Groundwater treatment system to be installed.	1982	Yes
Distler Farm Louisville–Jefferson Co.	Disposal of contaminated groundwater underway. Site will move into operation and maintenance.	1982	Yes
Fort Hartford Coal Olaton–Ohio Co.	Cleanup studies nearing conclusion. Remedial design expected to begin in 1995.	1990	Yes
General Tire & Rubber Mayfield–Graves Co.	Cleanup studies concluded. U.S. EPA determined no further remedial action is necessary.	1990	Yes
Green River Disposal Site Maceo–Daviess Co.	Cleanup studies concluded. Remedial design in progress.	1990	Yes
Howe Valley Howe Valley–Hardin Co.	Cleanup completed in 1994.	1987	Yes
Lee's Lane Landfill Louisville–Jefferson Co.	Operation and maintenance phase. MSD has agreed to conduct activities.	1982	Yes
Maxey Flats Hillsboro–Fleming Co.	Settlement negotiations ongoing.	1986	Yes
Newport Dump Wilder–Campbell Co.	Operation and maintenance phase. City of Newport to conduct activities.	1982	Yes
Red–Penn Sanitation Co. Peewee Valley–Oldham Co.	State and U.S. EPA are negotiating with responsible parties to conduct cleanup.	1989	Yes
Smith's Farm Brooks–Bullitt Co.	Remedial action ongoing at one site. Remedial design ongoing at other site.	1984	Yes
Tri–City Indstrl. Disp. Site Books–Bullitt Co.	Remedial action ongoing.	1989	Yes
Gaseous Diff. Plant Paducah-McCracken Co.	Long-term study ongoing.	1992	Yes
National Southwire Alum. Hawesville-Hancock Co.	Cleanup studies in progress. Interim action for groundwater remediation to begin in 1995.	1992	Yes
National Elec. Coil Dayhoit-Harlan Co.	Cleanup studies in progress. Interim action for groundwater remediation in progress.	1992	Yes

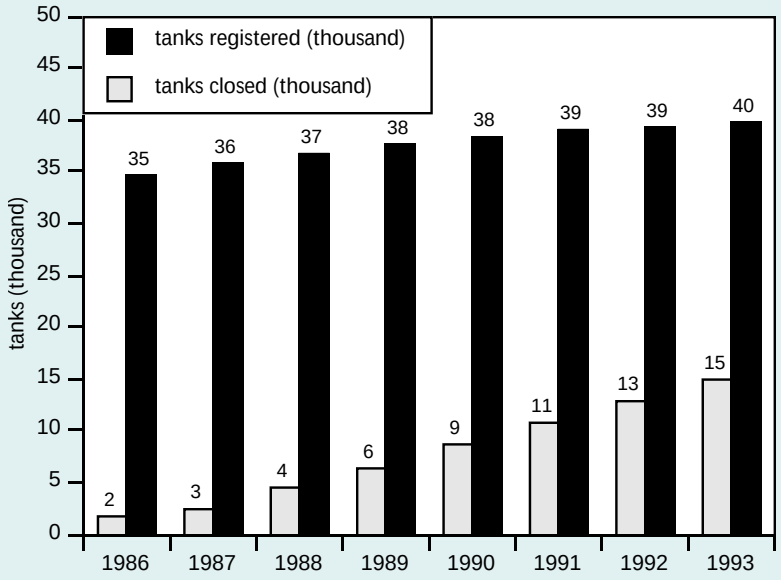
Source: Kentucky Division of Waste Management; U.S. Environmental Protection Agency, Region IV, 1994

The cleanup of the state's worst contamined sites, federal superfund sites, has been slow. Only three of the 20 federal superfund sites have been contained or remediated and are in the process of being delisted from the national priority list of waste sites. The U.S. EPA has also recommended that two other federal superfund sites in Kentucky require no further cleanup. The remainder of the sites are in some stage of study or cleanup or are involved in financial settlement negotiations. The U.S. Congress will be debating the reauthorization of the federal Superfund law in 1995.

II. Underground Storage Tank Indicators

Figure 12

Underground Storage Tanks in Kentucky

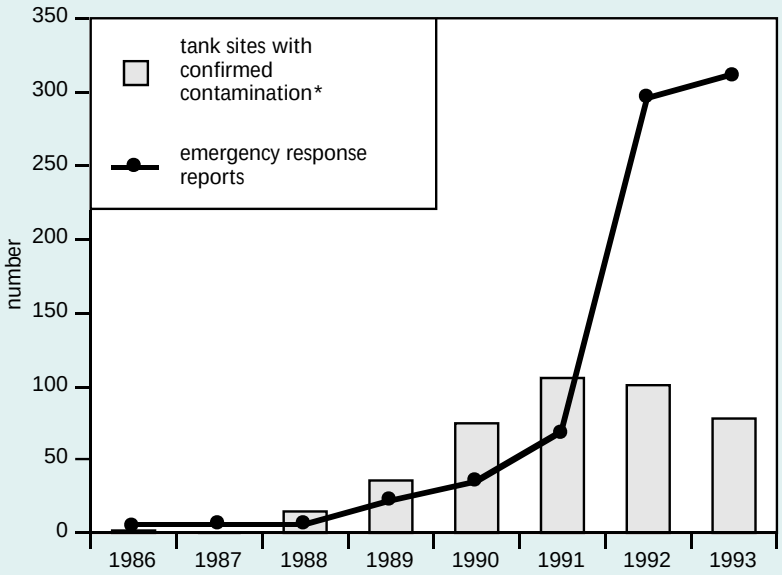


Note: Years show cumulative total.
Source: Kentucky Division of Waste Management, 1994.

Underground storage tanks, containing petroleum and other materials, number in the thousands. Their potential to leak and contaminate soil and groundwater led to federal and state requirements to register tanks, establish minimum tank construction standards, and address contamination problems at tank sites. Nearly 40,000 tanks have been registered with the state and 15,000 substandard tanks have been removed or closed to prevent contamination.

Figure 13

Underground Storage Tanks Contamination Problems

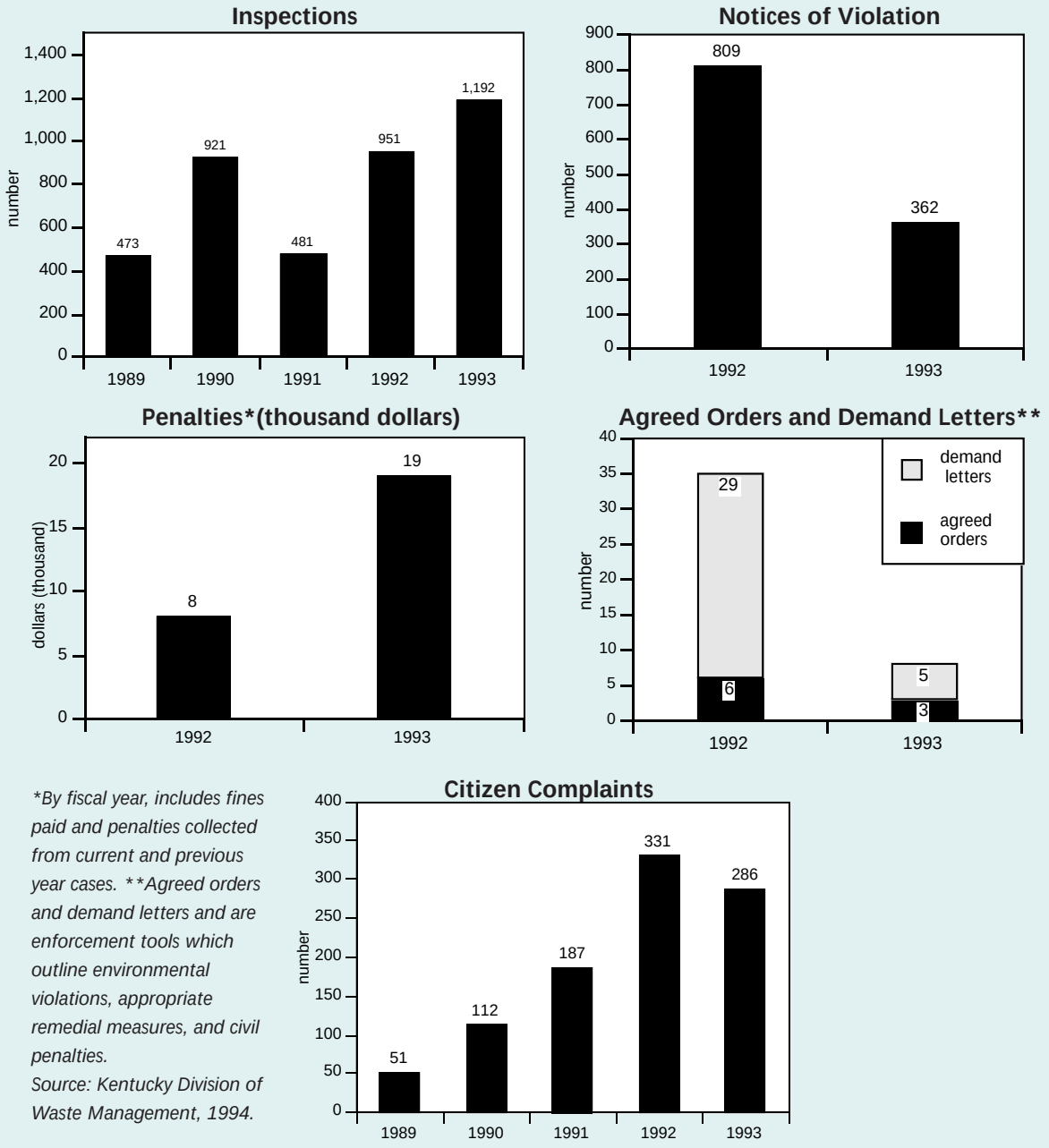


*Note: Number of tanks and responses for each calender year. *Groundwater and/or soil contamination.*
Source: Kentucky Division of Waste Management, 1994.

Each year state officials respond to numerous reports of leaking underground storage tanks. Many of these reports have led to the confirmation of soil or groundwater contamination. A state law was passed in 1992 and revised in 1994 requiring the promulgation of new soil and groundwater cleanup standards based on the level of risk posed to public health and the environment at these contaminated tank sites.

Figure 14

Underground Storage Tanks Enforcement and Compliance Measures



*By fiscal year, includes fines paid and penalties collected from current and previous year cases. **Agreed orders and demand letters and are enforcement tools which outline environmental violations, appropriate remedial measures, and civil penalties.

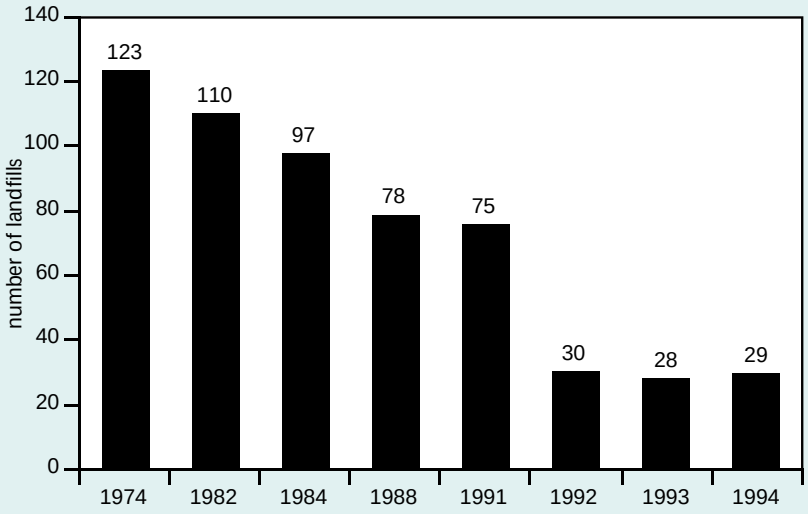
Source: Kentucky Division of Waste Management, 1994.

State inspections at underground storage tank sites have steadily increased as more tanks are removed and closed. The number of violations, however, has declined significantly since 1992 after the state changed its procedure of citing any release at a tank site. Violations are now based on noncompliance with spill plans or construction standards as well as failure to comply with specific regulatory requirements. The complaints received by the state pertaining to underground tanks are usually in regard to tank removals or suspected releases.

III. Solid Waste Indicators

Figure 15

Municipal Solid Waste Landfills in Kentucky

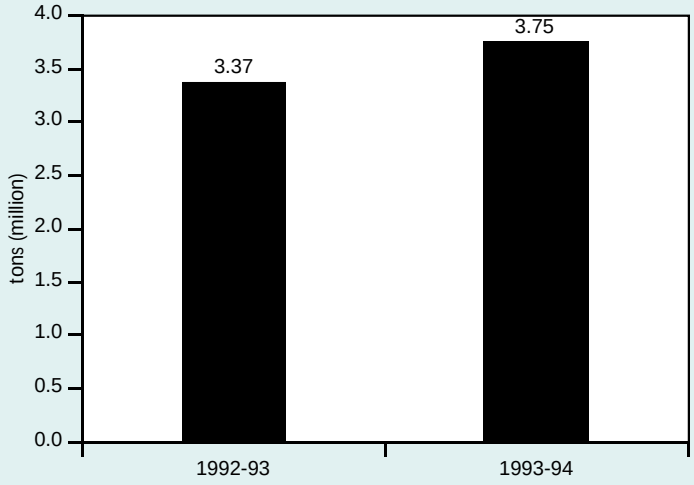


Note: Based on state permitted municipal solid waste landfills actively receiving waste.
Source: Kentucky Division of Waste Management, 1994.

More stringent state solid waste laws and regulations passed in 1990 and 1991 have led to the closure of many substandard landfills. The 29 municipal solid waste landfills currently in operation must upgrade to meet strict clay and plastic liner requirements to prevent groundwater contamination by July 1, 1995 or close. Currently, 13 of the 29 municipal landfills have groundwater contamination problems.

Figure 16

Solid Waste Disposal at Municipal Solid Waste Landfills in Kentucky

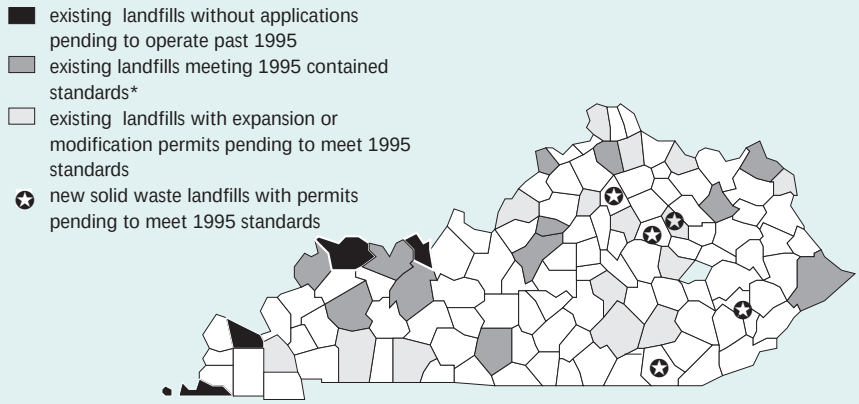


Note: Earlier data not available. By fiscal year (July 1-June 30) as reported by municipal solid waste landfills operating in Kentucky.
Source: Kentucky Division of Waste Management, 1994.

The amount of waste disposed at municipal solid waste landfills in Kentucky continues to increase as the number of households participating in garbage collection grows. Ninety-five percent of the 3.75 million tons of waste disposed at municipal landfills in fiscal year 1993-94 was Kentucky-generated household, commercial, industrial, and yard waste. The remaining waste disposed was from out-of-state, primarily from neighboring states.

Figure 17

Status of Municipal Solid Waste Landfills in Kentucky

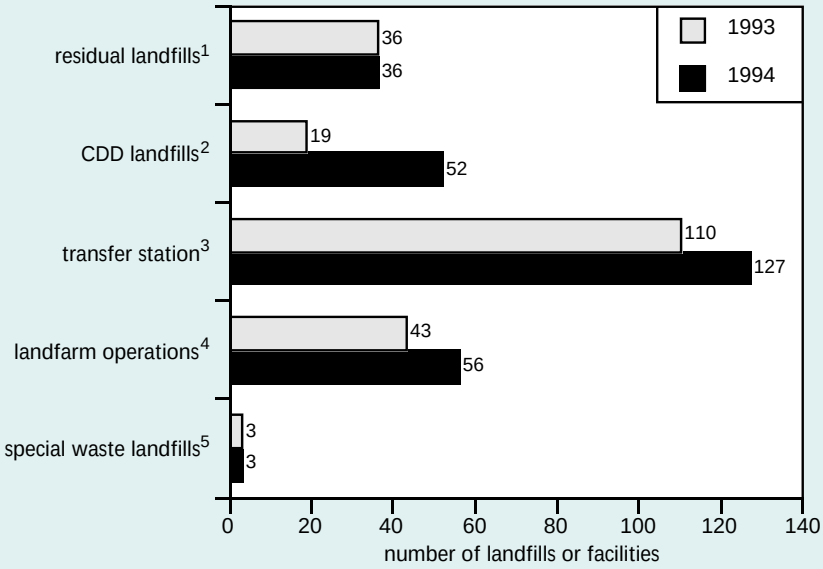


*Note: As of December 9,1994. *Contained landfills meet the 1995 clay and plastic liner and additional requirements. Operating permits have been issued in Greenup, Pike, Barren, Ohio, Grant, and Union counties. Construction permits for the expansion of existing landfills to meet 1995 contained standards have been issued in Trimble, Spencer, Nelson, and Rowan counties. Draft construction permits for contained landfills have been issued in Daviess and Hopkins counties. Source: Kentucky Division of Waste Management, 1994*

Many of the 19 private and ten publicly owned municipal solid waste municipal landfills currently operating in Kentucky have filed permits to upgrade to meet the July 1, 1995 requirements for a clay and plastic liners. Six of the existing landfills now meet the 1995 contained standards and four have received construction permits. The trend toward fewer but larger regional landfills continues. In 1991, the average amount of municipal solid waste disposed at a landfill was 44,000 tons annually, compared to 129,000 tons in 1994.

Figure 18

Other Facilities Receiving Various Types of Waste* in Kentucky

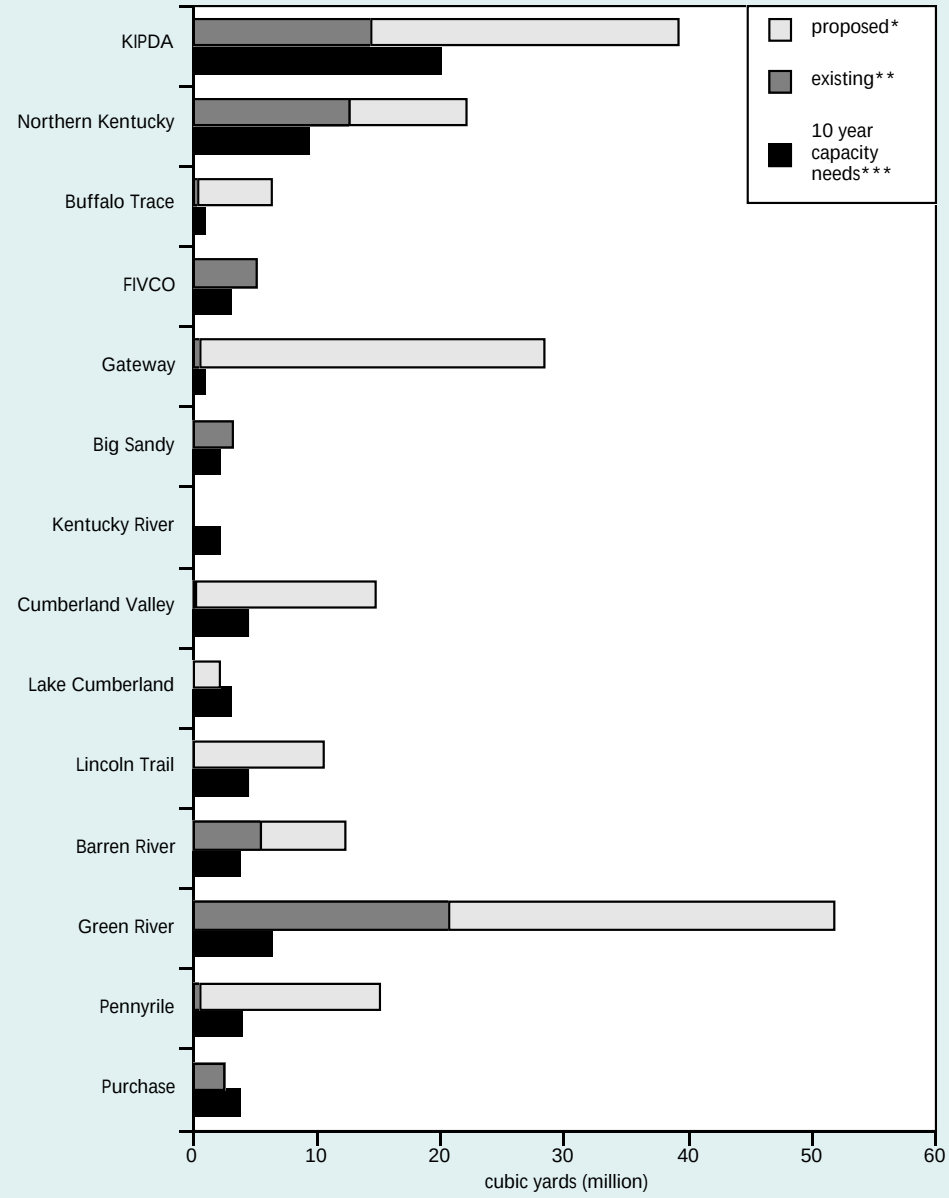


**Special or solid waste as defined by state law.[1]Receive industrial solid waste and solid waste by-products from the manufacturing process. [2]Construction and demolition debris landfills receive inert waste. Most are less than one acre (In 1994, two were more than one acre). [3] Any transportation related facility including loading docks, parking, areas where shipments of solid waste are held or transferred. [4]Permitted to dispose of sludge or special waste through land spreading. [5]Receive high volume, low-hazard waste which include but not limited to mining wastes, electric-generating utility ash, sludge, cement kiln ash, oil and gas drilling muds, and oil production brines. Source: Kentucky Division of Waste Management, 1994*

There are a number of facilities, other than municipal solid waste landfills, permitted to process or dispose different types of waste. Each facility is regulated differently based on the risks posed to the environment. The number of construction and demolition landfills has increased in recent years as the cost to dispose of this relatively inert waste at municipal landfills has increased. Construction and demolition landfills are not subject to the strict plastic and clay liner standards required for municipal solid waste landfills and are not required to monitor groundwater if they are less than one acre in size.

Figure 19

Existing and Proposed Capacity for Regional Municipal Solid Waste Landfills Compared to Projected Disposal Needs in Kentucky

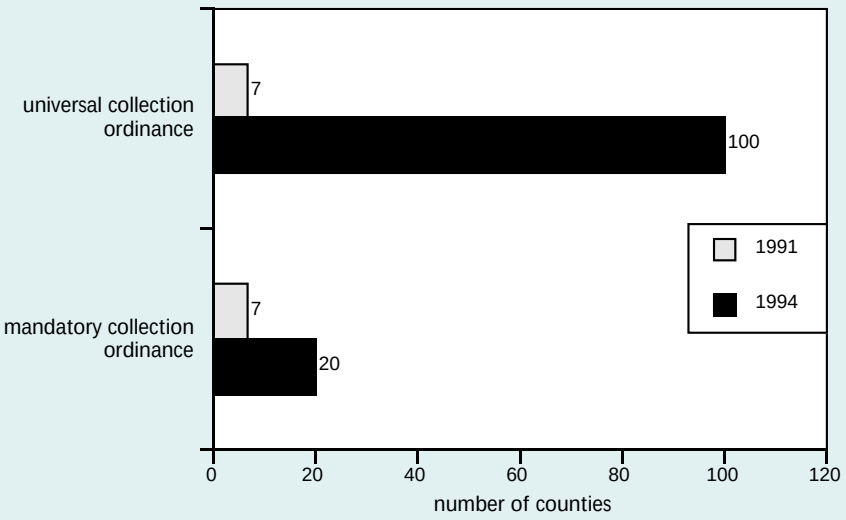


*Note: Data as of September 1994. Regions based on state Area Development Districts. *Includes proposed contained landfills, new or expansion applications, either in the review process or with construction permits. **Includes both residential and contained municipal solid waste municipal landfills with operating permits. ***Based on 10-year generation rates as provided by counties in solid waste plans converted to cubic yards (1 cubic yard=1,200 pounds of compacted in-place waste).*
Source: Kentucky Division of Waste Management, 1994

All counties now have long-range plans to assure future solid waste disposal needs. A review of existing and proposed landfill capacity, however, reveals that landfills are currently more concentrated in some regions of the state than others. Therefore, some waste must move greater distances to those areas with adequate landfill space. State officials predict that landfill capacity will balance out as regional landfills are permitted and disposal contracts are entered into between counties and landfills.

Figure 20

County Garbage Collection Ordinances in Kentucky

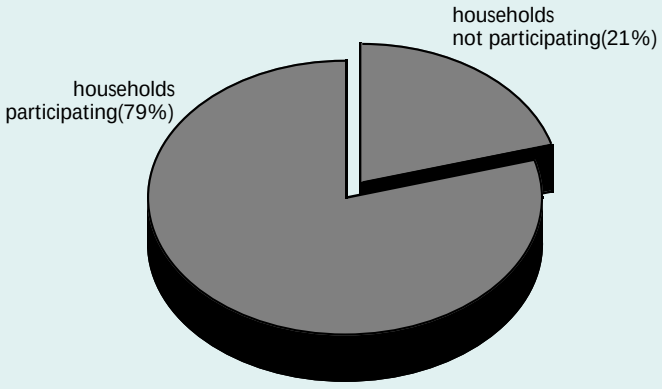


Note: Universal collection defined as residents having access to garbage collection but not required to participate. Mandatory collection requires residents to participate in garbage collection.
Source: Kentucky Division of Waste Management, 1994

State law now requires that local governments provide residents with access to garbage collection. A majority of the county collection ordinances passed are universal in nature and provide for voluntary participation. Only 20 counties have adopted collection ordinances that require mandatory participation.

Figure 21

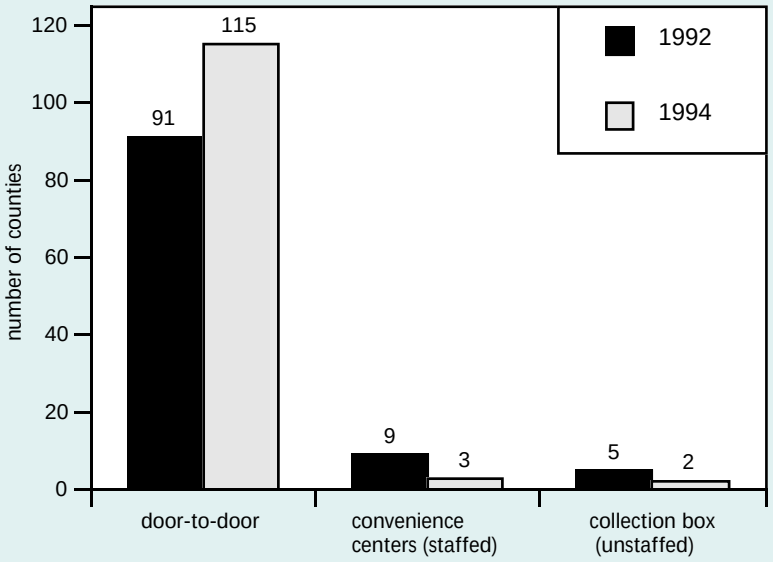
Number of Kentucky Households Participating in Garbage Collection (1993)



Note: Based on 1993 county solid waste annual reports. Total households 1,374,980. Total households with collection 1,090,808. Some county reports estimated household participation based on the use of convenience centers and collection boxes.
Source: 1993 County Solid Waste Annual Reports

It is difficult to determine the number of Kentucky households participating in garbage collection since most county collection ordinances are voluntary and some counties use collection boxes or convenience centers. According to county government estimates, about 79% of the households in the state currently participate in a garbage collection system.

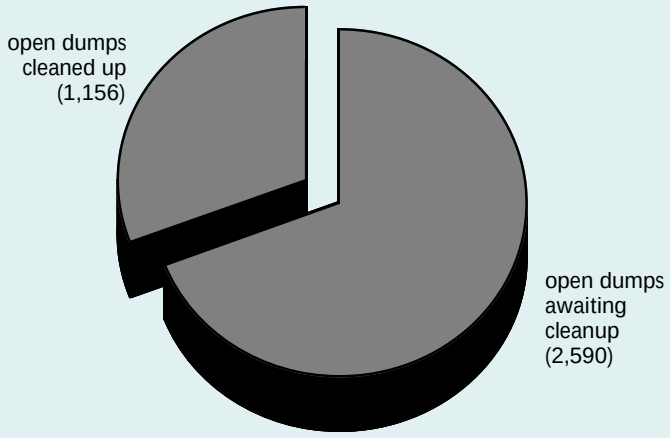
Figure 22
County Garbage Collection Systems in Kentucky



Note: Earlier data not available.
Source: Kentucky Division of Waste Management, 1994

An increasing number of Kentuckians now have access to door-to-door garbage collection. County governments are responsible for solid waste management at the local level and most have chosen to enter into public/private partnerships by franchising or issuing permits to private haulers for garbage collection services. Other communities have issued bonds or sought alternative funding sources such as tax increases to help upgrade publicly owned landfills and finance collection systems. Household garbage collection rates have also increased as the full cost of waste disposal begins to be realized. Rates currently range from $7 to $14 per month in 1994 compared to $4 to $6 per month in 1991.

Figure 23
Status of Open Dumps in Kentucky (1993)

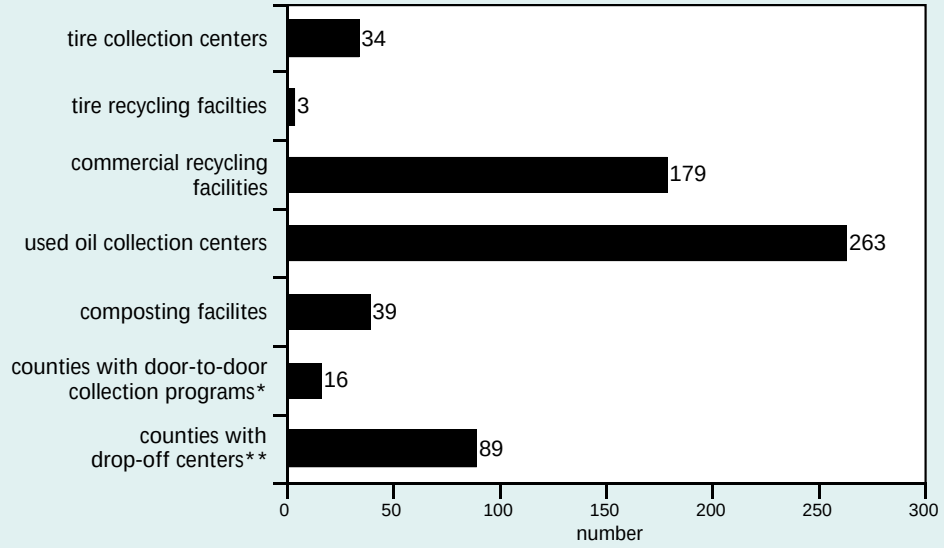


Note: Based on open dumps reported by counties in 1992 Solid Waste Management Plans and cleanups as reported in 1993 Annual County Solid Waste Reports.
Source: Kentucky Division of Waste Management, 1994

Providing access to garbage collection has assisted in curbing the illegal disposal of solid wastes in the state. However, because an estimated 21% of Kentucky households have chosen not to participate in garbage collection, open dumping continues to be a problem. Local government efforts to identify and clean up open dumps, as required under state regulations, are progressing but have been hampered by financial constraints.

Figure 24

Recycling Programs and Facilities in Kentucky



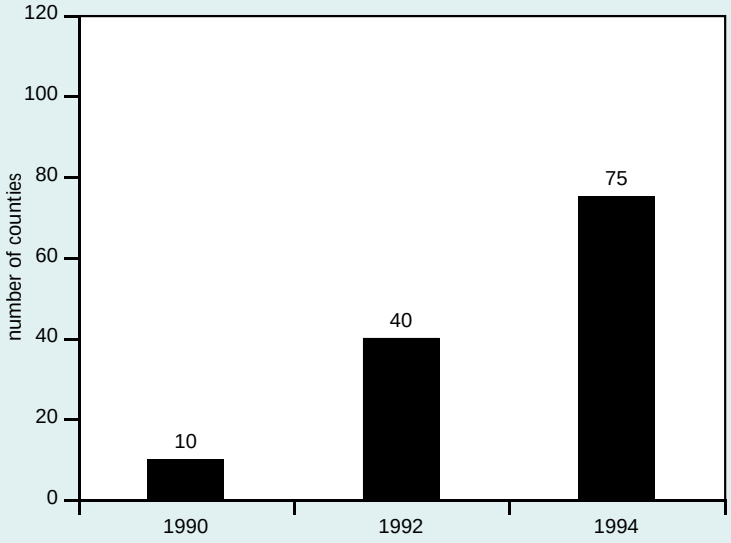
*Note: Based on those facilities and known to the Kentucky Division of Waste Management. There may be additional programs and facilities operating. *Counties where one or more communities have a door-to-door collection programs for recyclables. Does not necessarily mean all county residents have access to door-to-door collection. **Counties with one or more drop-off center for recyclables. Does not necessarily mean all residents have access to a drop-off center.*

Source: Kentucky Division of Waste Management, 1994

Recycling opportunities are increasing statewide with only a few areas out-of-reach of a recycling market. Many counties now have access to drop-off centers for recyclables. Door-to-door collection, however, is currently limited to the more populated areas of the state. In 1991, the General Assembly passed a goal to reduce the weight of municipal solid waste generated per capita 25% by 1997. However, the amount of waste recycled in Kentucky is difficult to determine since facilities that process these materials are not now required to register with the state nor report the amount of materials recovered.

Figure 25

Counties with Solid Waste Coordinators in Kentucky

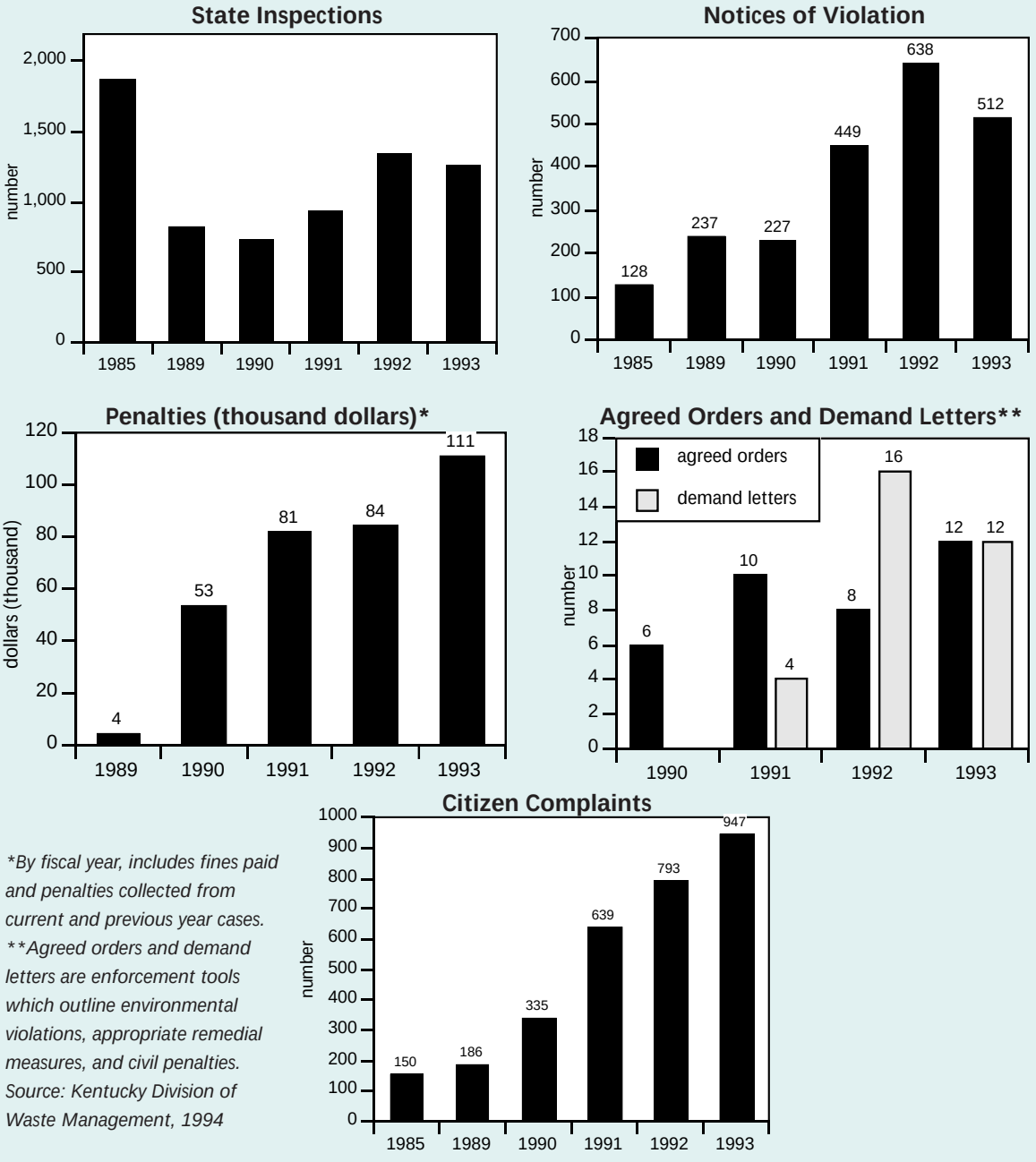


Source: Kentucky Division of Waste Management, 1994

Counties that have hired solid waste coordinators are generally having the greatest success in implementing a comprehensive solid waste management program. Solid waste coordinators work to promote better waste management practices through public education and local and state programs.

Figure 26

Solid Waste Enforcement and Compliance Actions



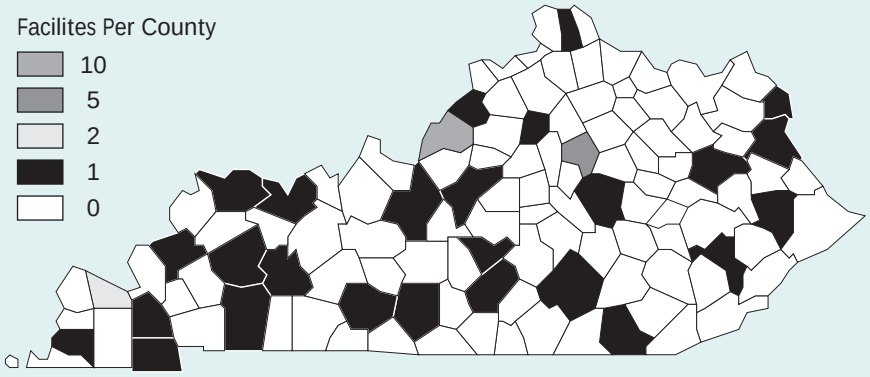
*By fiscal year, includes fines paid and penalties collected from current and previous year cases.
**Agreed orders and demand letters are enforcement tools which outline environmental violations, appropriate remedial measures, and civil penalties.
Source: Kentucky Division of Waste Management, 1994

The effectiveness of state solid waste laws in protecting the environment depends upon compliance by regulated facilities. During 1992, the number of violations reached record levels as new solid waste rules and requirements took effect. With the closure of many substandard landfills in 1992, the number of violations has since declined. Background checks to identify past environmental violations by owners and operators of 25 proposed solid waste landfills only uncovered one problem. Eight background investigations at proposed contained landfills are currently underway. The number of citizen complaints has risen in recent years and led to the identification of many hazardous waste dumps across the Commonwealth.

IV. Medical Waste, Low-Level Radioactive Waste Indicators

Figure 27

Medical Waste Incinerators in Kentucky

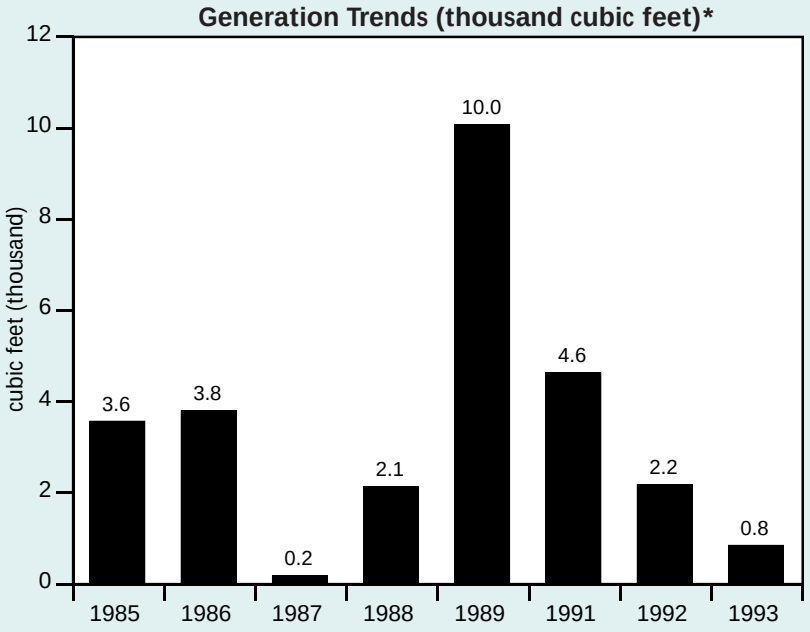


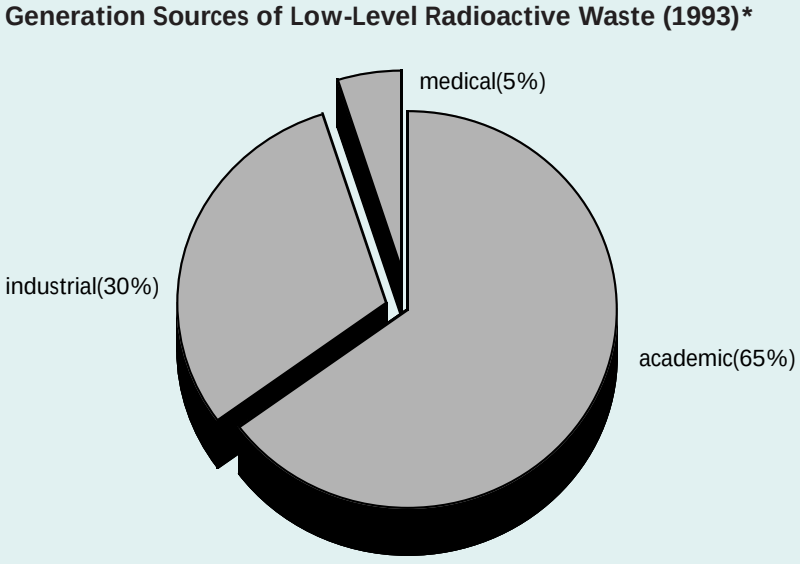
Note: Based on Kentucky Division of Air Quality Emission Inventory System Database for pathological waste incinerators and data provided by Jefferson County Air Pollution Control District.
Source: Kentucky Division for Air Quality; Jefferson County Air Pollution Control District, 1994

There are 44 medical waste incinerators permitted in Kentucky. Most are small incinerators run by hospitals that burn less than 500 pounds of waste per hour. Two permitted medical waste incinerators that are not hospital-operated are Medisin in Floyd County and BFI in Jefferson County. Medical waste incinerators must now meet stricter state emission limits, which took effect December 31, 1994, for particulates and carbon monoxide and other pollutants based on the size of the facility. The Division for Air Quality is in the process of verifying compliance with the new rules. Proposed federal rules to further limit toxic and other air emissions from medical waste incinerators are expected to be released in early 1995.

Figure 28

Low-Level Radioactive Waste Generated in Kentucky by Licensed Facilities*



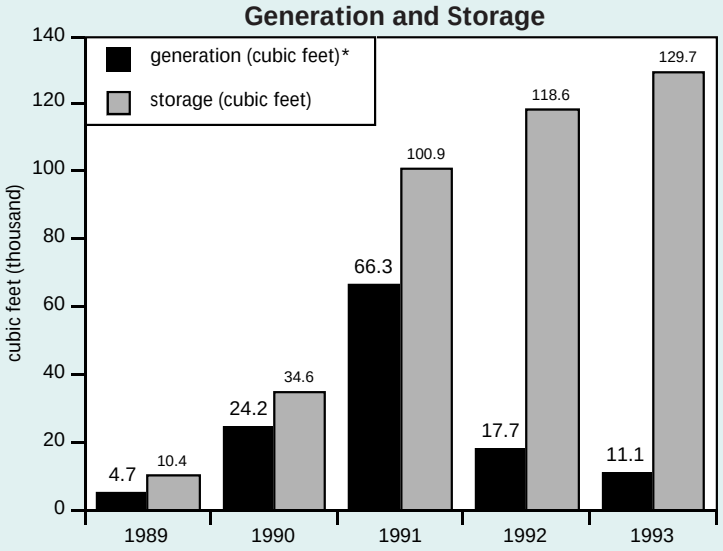


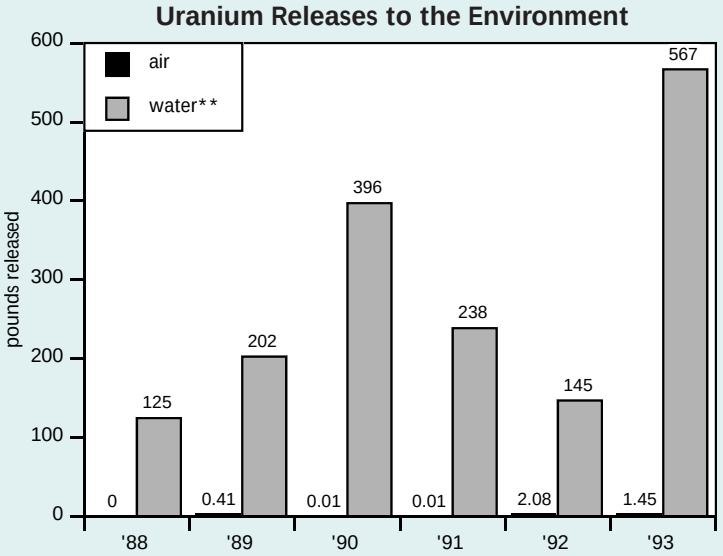
**Does not include low-level radioactive waste generated by the U.S. Enrichment Corporation Gaseous Diffusion Plant in Paducah which is exempt from state licensing requirements.*
Source: Kentucky Department of Health, Radiation Control Branch, 1994

The state currently licenses 404 facilities to receive, handle, and dispose of low-level radioactive waste. Most low-level waste generated in Kentucky has been sent out-of-state for disposal, although small amounts of radioactive waste are allowed to be released as federally permitted discharges to sanitary sewers. The three disposal facilities accepting Kentucky-generated low-level waste in Nevada, Washington, and South Carolina recently announced they will limit access to only those states with regional agreements. Kentucky has an agreement with the state of Illinois to dispose of its low-level radioactive waste. However, Illinois has yet to site a low-level waste disposal facility. Hospitals, biotech companies, and universities that generate radioactive wastes in Kentucky will now be forced to store it on-site until a disposal facility is located in Illinois.

Figure 29

Low-Level Radioactive Waste Generation, Storage, and Releases at the U.S. Enrichment Corporation Paducah Gaseous Diffusion Plant





*Note: In 1992 and 1993, 1,350 cubic feet of low-level waste generated by the Gaseous Diffusion plant was sent to Hanford Washington for disposal. *Scrap metal contaminated waste not included. Data from the Paducah Environmental Reports 1989-92. Data from the Performance Indicator Reports for 1993. **Uranium releases to water through sewers, drains, and runoff.*
Source: U.S. Department of Energy, Oak Ridge Operations, Paducah Site Office, 1994; Paducah Gaseous Diffusion Plant, Annual Site Environmental Report, 1993

The U.S. Enrichment Corporation is a federal government/ corporation established to operate the U.S. Department of Energy's two enrichment facilities in Paducah, Kentucky and Portsmouth, Ohio. The Paducah facility is the largest generator of low-level radioactive waste in the state. The plant enriches uranium for use as fuel in commercial nuclear reactors and for propulsion in Navy nuclear vessels. A majority of the low-level radioactive waste generated by the plant is currently stored on site. Groundwater contaminated with radioactive isotopes and other wastes was discovered in water wells near the site in 1988. Since then, $166 million has been spent to study environmental problems at the complex. Another $2 million has been allocated annually by the U.S. Department of Energy to the state to hire 20 employees to oversee clean up at the site. Studies reveal that groundwater contamination has spread more than three miles from the plant's border to within a few hundred feet of the Ohio River. The U.S. Department of Energy is developing a plan to halt the spread of contamination and clean up the plant site. Waterlines are also being extended to about 100 households near the plant.

Chapter 4

Toxics

Toxics

December 1994, marked the 10th anniversary of the tragedy that killed more than 7,000 people and injured thousands more in Bhopal, India, during an accidental release of toxic chemicals from a Union Carbide plant. Another dangerous leak at a similar facility in West Virginia sparked Congress to pass the Emergency Planning and Community Right to Know Act in 1986 which mandates public disclosure of industrial toxic chemical releases to the environment.

The act requires large manufacturers to report to the public the amount of more than 300 toxic chemicals generated, disposed in landfills, released to the air and water, or otherwise managed at their facilities. The Community Right to Know Act also expanded reporting for toxic spills and provided the framework for emergency response services statewide and in local communities.

This chapter includes indicators that measure the amount and type of industrial toxics released, disposed, and recycled each year in Kentucky by facilities required to report under the act. Indicators also track the progress Kentucky industries are making in reducing releases of 17 "priority" toxic chemicals. Other pollution prevention activities and policies are reviewed as are toxic spills and health issues related to toxic releases, exposure to lead in homes, and lawn care pesticide use.

I. Toxic Pollutant Indicators

Overall, industrial toxic chemical releases from reporting sources in Kentucky declined between 1988 and 1992, although indicators reveal a steady increase in emissions during the 1990's.

The amount of toxics released to the environment increased 30% between 1990 (54 million pounds) and 1992 (70 million pounds), primarily due to the generation and disposal of large volumes of hydrochloric acid by E.I. duPont in Jefferson County. The company was injecting the waste underground, but found a market for the acid and stopped disposing it in 1993.

Releases to water, land (excluding underground injection), and air have generally stabilized or show declining trends during the 1990's. Kentucky was ranked 15th in the nation for the amount of toxics released by manufacturers during 1992.

The amount of toxics disposed off-site of the generating facility continued to decrease during the 1990's. This reflects a shift by generators toward recycling and less expensive treatment such as blending toxics with other fuels and using them as an energy source.

Highlights

- Industrial toxic releases to the environment in Kentucky declined 17% between 1988 and 1992. However, toxic releases to the environment showed increasing trends in the 1990's, rising 30% between 1990 and 1992.
- Ten facilities, in seven counties, accounted for 70% of the toxics released in the state during 1992.
- Generation of 17 priority toxic chemicals, designated for reduction by the U.S. EPA, declined 33% between 1988 and 1992 in Kentucky, meeting a national toxics reduction goal.
- Releases of lead, chromium, cadmium, and heavy metals associated with adverse health and environmental effects, declined 88% between 1988 and 1992 as a result of industry efforts to reduce toxics.
- Monitoring of lead levels in children's blood shows that about one percent of the children tested in Kentucky between 1992 and 1994 had levels linked to severe and fatal health effects. Another 13% had levels high enough to cause mental retardation and developmental problems.
- During 1993, 3,058 toxic spills and accidental releases were reported to state officials, an average of more than eight per day.

Top 10 Facilities. The top ten facilities with toxic releases and transfers for treatment or disposal in Kentucky reported generating 52.6 million pounds of toxics during 1992, nearly 35% of the toxics reported that year. The top ten generators sent less of these chemicals off-site for recycling in 1992 (4.7 million pounds) than in 1991 (5.9 million pounds). It is difficult to assess the extent of recycling of toxic chemicals since complete data about on-site recycling conducted at industrial facilities is not available.

Air Toxics. Most toxics released to the environment in Kentucky are discharged to the air. The amount of toxic air releases has declined in recent years. Kentucky facilities reported releasing 38.6 million pounds of toxics to the air during 1992, compared to 47 million pounds during 1988, a 16% decrease.

Pollution prevention efforts have helped reduce air releases in Kentucky. For example, GTE (now OSRAM Sylvania Inc.) in Woodford County reduced air toxic releases by 73,700 pounds between 1988 and 1992, while increas-

ing production 31%. This represents an effective 26% reduction in pounds of air toxics released per unit of production. All production capacity added since 1984 uses water-based coating processes which have no toxic air releases. OSRAM Sylvania also reports it is currently testing a solvent recovery system which, if implemented, would eliminate more than 80% of the air toxics released at the facility.

Sherwin-Williams in Madison County reports it has successfully reduced off-site transfers of a 3.2 million pound waste stream containing a solvent used during processing. The company formerly sent the waste solvent off-site to be cleaned up and reused. Sherwin-Williams has added equipment that cleans up the waste on-site where it is reused in processing. This resulted in an annual 94% reduction in the waste stream and allowed the company to avoid transporting the material off-site.

The Clean Air Act Amendments of 1990 will further address the issue of toxic air releases. The amendments mandate that standards be set for 189 toxic air pollutants over the next 10 years and that maximum available control technologies to limit toxic emissions be installed at new and modified facilities.

Priority Toxics. The U.S. Environmental Protection Agency began a national effort to reduce industrial generation of 17 "priority" chemicals that are considered highly toxic, cancer causing, or used in great volumes that pose significant environmental risk. More than 21 million pounds of the 17 priority chemicals were released or transferred for disposal or treatment by Kentucky facilities during 1992, compared to 32 million in 1988.

U.S. EPA's 33/50 Program encourages industries to voluntarily reduce generation, emission, and disposal of the priority toxics 33% by 1992 and 50% by 1995. More than 100 parent companies with facilities in Kentucky have pledged to reduce generation of priority chemicals by participating in this program.

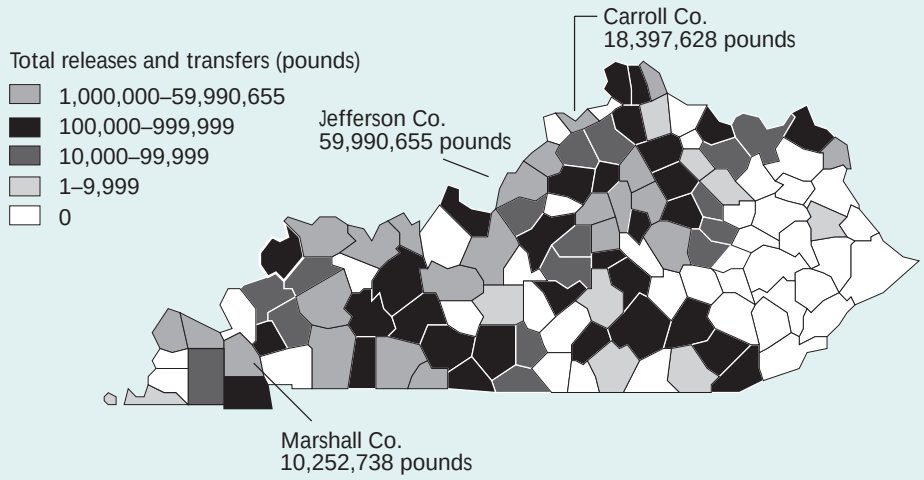
Industry efforts to reduce priority toxic chemicals have paid off. Efforts by those industries participating in the 33/50 program, combined with other pollution prevention measures at nonparticipating facilities, enabled Kentucky to meet the national 33% reduction goal in 1992.

Ashland Petroleum in Boyd County reported a 29% decline in the generation of priority chemicals between 1988 and 1992. The reductions were achieved through a variety of measures that focused on reducing leaks of benzene, toluene, and other solvents; phasing out the manufacturing of leaded gasoline; and eliminating heavy metals used in the facility's wastewater treatment plant.

Overall, manufacturers reported substantial reductions in releases and transfers of several heavy metals known to adversely impact human and ecological health. Lead, chromium, and cadmium releases/transfers were reduced nearly 88% between 1988 and 1992. Releases and transfers for treatment or disposal of chromium, a known human carcinogen, declined from 2.6 million pounds to 80,000 pounds during that time.

Pollution Prevention. Preventing pollution has become a top environmental priority nationwide. Industry, government regulators, and the public generally agree it is more desirable to prevent pollutants from being produced, rather than treating and disposing toxic chemicals.

Toxic Releases and Transfers from Reporting Sources in Kentucky (1992)



Note: Includes releases, transfers for further treatment and disposal, and transfers for recycling and energy recovery.
Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Report 1992

Industry pollution prevention efforts are resulting in significant reductions in toxic releases. For example, Air Products and Chemical Company in Marshall County reduced toxic releases to the environment 40% through a combination of source reduction, changes in operations, and capital improvements. The company reports it invested more than $10 million for air pollution controls including a flare, higher efficiency baghouses, and other measures to reduce emissions.

The facility also developed leak detection and repair programs and other preventative maintenance procedures to reduce emissions. Air Products and Chemical Company achieved these reductions, while at the same time expanding the capacity of each of its production units.

During 1994, the Kentucky General Assembly passed the Environmental Leadership Act. The act encourages facilities that began operation before 1987 to reduce the generation of toxics and hazardous wastes 25% by 1997 and 50% by 2002. Facilities that began operation after 1987 will be encouraged to reduce pollutants 25% within 10 years and 50% within 15 years.

The state has been offering limited technical assistance to industries to encourage pollution prevention through source reduction and waste minimization. The Kentucky Partners Program, funded in part by the U.S. EPA, has provided technical assistance to more than 140 facilities since 1988. Collectively, an estimated $3.1 million is saved annually by companies that have implemented the recommended pollution prevention measures.

The Environmental Leadership Act incorporates the mission of the Kentucky Partners Program into a new Pollution Prevention Center. The Center will facilitate technology transfer and provide other technical assistance to sources that generate materials targeted for reductions.

Supplemental Environmental Projects. Facilities that violate environmental laws are typically assessed penalties based on factors such as intent to violate laws and the severity of the problems caused by the violation. The U.S. EPA is promoting the use of "supplemental environmental projects" (SEPs) as an enforcement tool to encourage additional investments in pollution prevention measures and equipment.

Facilities with violations may agree to a SEP in place of a portion of an assessed fine, under certain conditions. SEPs must be related to the violation and result in improvements beyond what is required to remediate the existing problem. Typical SEPs involve pollution prevention measures, environmental enhancement, expanded auditing for problems, and public awareness projects related to enforcement issues.

The Department for Environmental Protection is moving toward the use of pollution prevention in resolving enforcement cases. The U.S. EPA will soon release new SEP guidelines that are expected to enhance the use of these projects in Kentucky.

II. Toxics and Health Indicators

During the past several years, additional efforts have been made to determine the effects of toxic chemicals and other pollutants on human health and ecosystems. However, assessing the synergistic impact of exposure to multiple chemicals is a complex task.

Risk Assessment. Regulators and industry have relied on "risk assessments" to identify potential health effects that could result from toxic releases or wastes. These assessments are used to quantify the health and environmental risks posed by a pollutant and help guide the development of environmental standards and the cleanup of contaminated sites. However, some groups assert risk assessments are based on questionable assumptions and erroneously focus on how much pollution can be tolerated by the environment and living things, rather than how little.

The use of risk assessments is increasing in Kentucky and the nation. House Bill 540, passed by the legislature in 1992, clarified the use of risk assessment for waste site cleanups. To date, 254 cleanup plans involving risk assessment have been submitted to the state for review, although many were resubmitted because of inadequate data or other deficiencies. A work group, comprised of a wide range of interests, was convened by the Natural Resources and Environmental Protection Cabinet to assist in site characterization and risk assessment.

Comparative Risk Project. The concept of environmental risk is also serving as the foundation for setting state priorities through a process called "comparative risk analysis." In 1993, the state initiated a comparative risk project, Kentucky Outlook 2000. The project has enlisted the expertise of health professionals, ecologists, and others to assess the extent of contaminants and the potential risks posed to humans and ecosystems from toxic releases and other pollution. The comparative risk assessment will assist officials in targeting efforts to reduce risks to health, the environment, and the quality of life.

Toxic "Hot Spots." For many years, Kentuckians have expressed concerns about toxic releases in their communities. Those living in the highly industrialized areas of Calvert City and Catlettsburg have been among the most vocal, voicing concern about the potential effects of exposure to multiple chemicals.

In response, the Kentucky Department for Environmental Protection developed two geographic initiatives, known also as ecosystem approaches. This type of project is slowly gaining recognition as a way to solve environmental problems in localized areas. The initiatives take a holistic approach to identifying and solving problems that otherwise may not be accomplished by the traditional focus on individual facilities. Geographic initiatives are defined as multimedia (air, land, water) efforts, although the primary emphasis of Kentucky's projects has been on airsheds.

The Tri-State Initiative targets a six-county area in the

small corner of three states—Kentucky, West Virginia, and Ohio. The area includes 360,000 residents and more than 40 large industries which have an annual emission inventory of 117 million pounds of toxic air pollutants. The Tri-State Initiative includes air toxics monitoring; toxics reduction initiatives; a ranking of industrial clusters by emissions, toxicology of chemicals, chemical accidents and populations; water quality monitoring; and corrective actions. The study has been underway since 1992.

The Calvert City Initiative began in 1989 and targets an industrial complex in this Western Kentucky community. The project includes a cancer cluster investigation; monitoring for air toxics; identification of hardwood forests that may be impacted by air pollution; soil sampling; and an analysis of groundwater flow and contaminant transport underneath the industrial complex. The study is expected to be completed in 1995.

Blood Lead Levels in Children. Direct releases of lead have declined dramatically in recent years as lead-based gasoline was phased-out and other pollution sources have been better controlled. Industrial air emissions of lead declined 82% in Kentucky between 1988 (1.4 million pounds) and 1992 (280,00 pounds).

Most exposure to lead, which has been shown to impair the health of people, particularly young children, is now linked to homes and other buildings that contain lead-based paint. Children are typically exposed to lead by eating paint chips or breathing paint dust in the home or at child care facilities.

The U.S. Department of Housing and Urban Development reports that 75% of the homes built prior to 1978 have lead-based paint. Based on this, 875,000 Kentucky homes may contain lead-based paint. Of these, 17% (148,750 homes) are estimated to have young children considered at risk from lead exposure.

The Kentucky Cabinet for Human Resources operates a lead poisoning prevention program for children six months to six years of age. The program coordinates blood lead testing and education efforts conducted through local health departments. Comprehensive services are available in the areas of the state considered to be at greatest risk for environmental lead exposure. These include Jefferson, Fayette, Grant, Kenton, Campbell, and Boone counties.

In 1994, more than 32,000 tests were conducted to determine blood lead levels in Kentucky children ages six months to six years. The monitoring detected lead poisoning (blood levels >20 ug/dL) in nearly 1% of the children tested. Another thirteen percent of the children tested during 1994 had levels high enough to be at risk for mental retardation and other developmental problems (blood lead levels >10 ug/dL).

Kentucky was recently criticized for failing to inspect child care facilities for lead contamination in a 1993 report released by the General Accounting Office, a Congressional investigation agency. The agency indicated more should be done to ensure lead hazards are prevented at these facilities. Lead poisoning is considered by health officials to be one of today's most preventable child health problems.

III. Lawn Care Chemical Indicators

The health and environmental problems associated with pesticides are not well quantified in Kentucky. However, it is known that at certain levels pesticides can cause serious health and environmental problems. The use of pesticides and other chemicals for lawn care has expanded considerably as more companies offer services in Kentucky.

Chemical Use. There are presently 2,090 commercial applicators licensed by the state to apply pesticides for lawn care purposes. The Division of Pesticides estimates approximately 500 lawn care companies are operating in the state.

During 1993, the division conducted a survey of major lawn care companies, large golf courses, and right-of-way spray contractors to determine the amount of chemicals used for lawn care. The surveyed users reported 497,250 pounds of active pesticide ingredients were applied for lawn care during 1993 in Kentucky. The pesticide 2,4-D led in usage at 122,576 pounds. However, the survey was not completed by the division, so a full accounting of chemical use by these companies cannot be determined.

Contamination Problems. The intensive and concentrated use of lawn care chemicals, particularly in densely populated areas, has raised concern about the potential of these pesticides to contaminate waterways and impact public health. Runoff in urban areas has been shown to carry these chemicals into sewers, where they can pass through the sewage treatment plant untreated and be discharged to the receiving waterbody.

During 1994, the City of Lexington experienced problems with pesticide contamination in the sewer system that was linked to the use of Diazinon. A public education program designed to teach Lexington residents about proper pesticide application has been required by the state to reduce pesticide runoff in the city.

Diazinon has been widely used in the United States for lawn and garden purpose, as well as on golf courses and crops. Nearly 12,000 pounds of Diazinon were sold in Kentucky during 1993 by sources required to report sales. The chemical is among the ten leading pesticides used by commercial lawn care companies, golf courses and others included in the lawn care chemical sales survey, according to Division of Pesticides.

IV. Toxic and Hazardous Spill Indicators

Each year, thousands of spills of toxic or hazardous materials occur in Kentucky. Industries and others handling these materials are required to report spills and accidental releases to the state and other agencies.

Spills of toxic materials caused several highly publicized

emergencies in recent years. During 1993, 3,058 spills and accidental releases were reported to the state, an average of more than eight per day. More than 100 spills along the Ohio River were also reported to the Ohio River Valley Water Sanitation Commission during 1993.

A spill of ethylene dibromide on the Ohio River shut down public drinking water systems in several Kentucky communities during 1994 and prompted and an advisory against using the river for contact recreation.

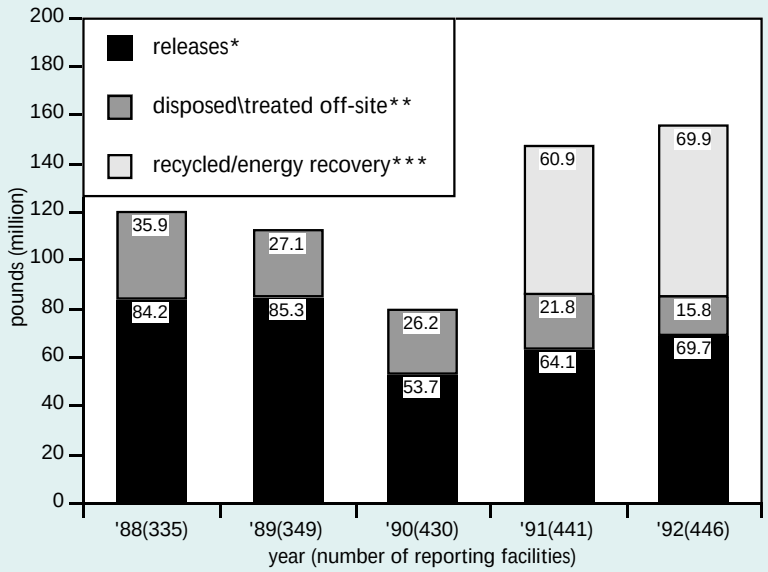
Lexington experienced two spills requiring evacuations and business closings during that year. These episodes and similar ones occurring statewide along transportation routes and in areas of high industrial activity continue to pose threats to area residents and the environment.

The Kentucky Department for Environmental Protection indicates there is a need for measures designed to eliminate or reduce the use of potentially dangerous substances. Historically, most efforts to deal with spills have involved "secondary" measures such as adding sprinkler systems and double-walled tanks aimed at containing spills and mitigating adverse effects. ■

I. Toxic Pollutant Indicators

Figure 1

Generation of Toxic Chemicals in Kentucky



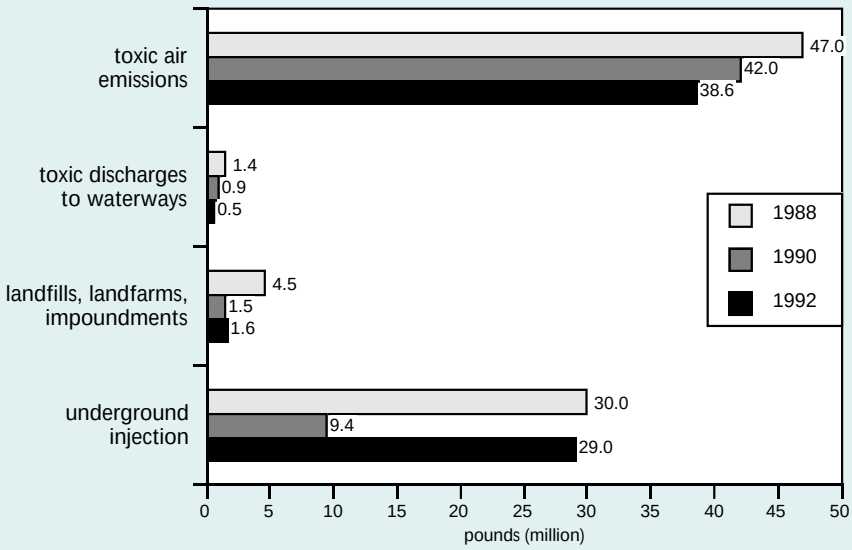
*Note: Delisted chemicals are not included. Newly added chemicals are included in 1990-92 data. *Includes air releases, stream discharges other than those discharged to publicly owned treatment works, underground injection, and on-site disposal in landfills, landfarming, and surface impoundments. ** Includes releases to off-site transfers for treatment (such as incineration and discharges to POTWs)), disposal, or unspecified management. ***Energy recovery includes chemicals blended for fuel or otherwise used as an energy source. Facilities were not required to report chemicals transferred for recycling or energy recovery prior to 1991.*

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92.

Assessing trends in the generation of toxic chemicals is difficult because reporting requirements have changed nearly every year since large manufacturing industries were first required to report in 1987. However, a general analysis indicates a 17% decrease in the reported amount of toxics released to the environment and a 56% decline in the amount disposed or treated off-site between the years 1988 and 1992. The 30% increase in toxic releases between 1990 and 1992 is attributed to the E.I. duPont chemical plant in Jefferson County as well as new sources and plant expansions.

Figure 2

Toxic Chemical Releases to Kentucky's Environment*



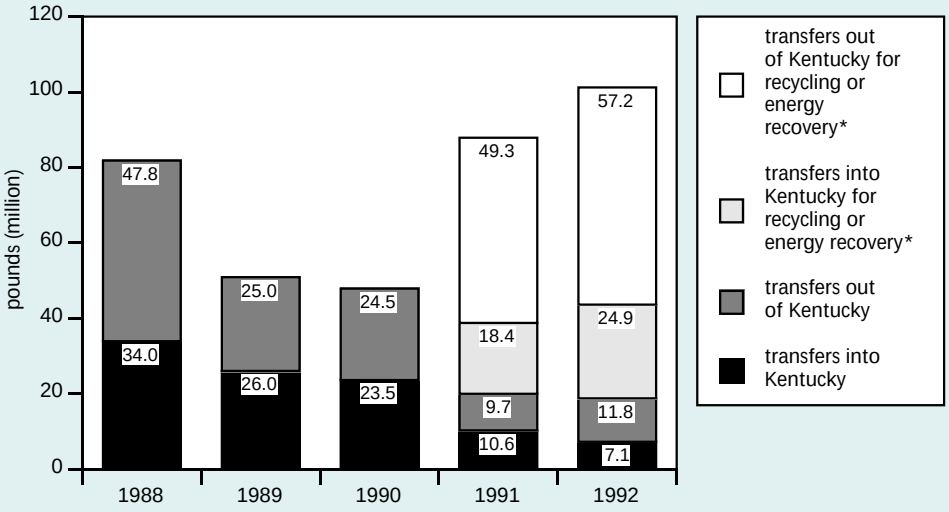
*Includes releases to the air, waterways, underground, or disposed on-site in landfills, landfarming, or surface impoundments and chemicals added to the reportable list.

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92.

Each year, millions of pounds of toxic chemicals are released to the environment. Many industries are now focusing greater attention on reducing these releases. As a result, reported industrial air toxic releases declined 16%, stream releases dropped 69%, and releases to impoundments or landfills decreased 71% between 1988 and 1990. Underground injection of toxics fluctuated greatly during this period.

Figure 3

Toxic Chemical Transfers Into and Out of Kentucky



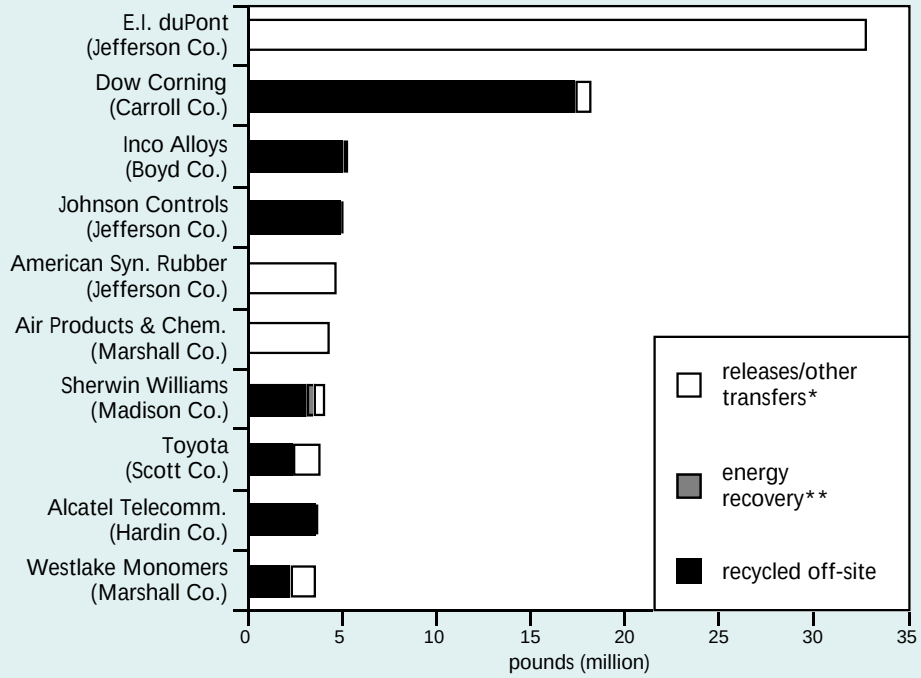
*Energy recovery includes chemicals blended for fuel or otherwise used as an energy source. Facilities were not required to report chemicals transferred for recycling or energy recovery prior to 1991.

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92.

The amount of toxics sent into and out of the state for treatment and disposal showed declining trends between 1988 and 1990. However, new reporting requirements in 1991 and 1992 reveal that a majority of imported toxic chemicals were sent to Kentucky to be recycled or blended with fuel or otherwise used as an energy source.

Figure 4

Top Ten Generators of Toxic Chemicals in Kentucky



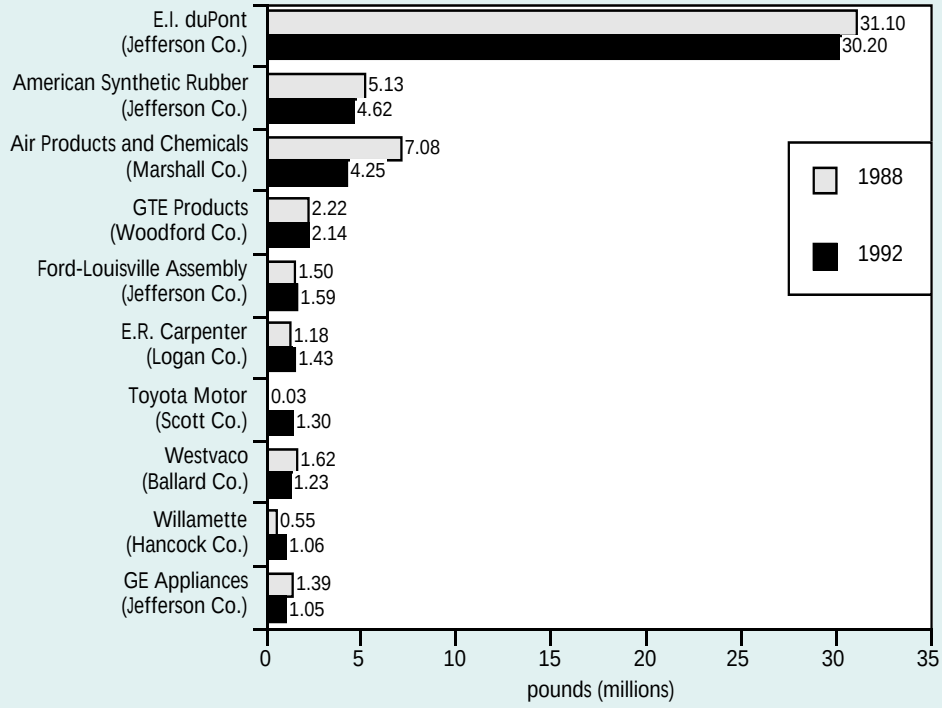
**Other transfers include discharges to publicly owned waster treatment plants, off-site transfers for disposal. Earlier data not included due to changing reporting requirements during the 1990's. ***Energy recovery includes chemicals blended for fuel or otherwise used as an energy source. Facilities were not required to report chemicals transferred for recycling or energy recovery prior to 1991.*

Source: Toxic Release Inventory Report, 1992.

Thirty-four percent of toxic chemicals generated in Kentucky came from ten industries during 1992. The top ten facilities reported toxic chemical releases and transfers of nearly 53 million pounds during both 1991 and 1992. These facilities also reported sending off-site for recycling another 9% (4.7 million pounds) of the toxics generated during 1992. It is important to note that on-site recycling activities, which are conducted at many facilities, are not included. The U.S. EPA is revising reporting guidelines for on-site recycling that will assist in assessing the extent of these activities.

Figure 5

Top Ten Facilities Releasing Toxic Chemicals to the Environment in Kentucky

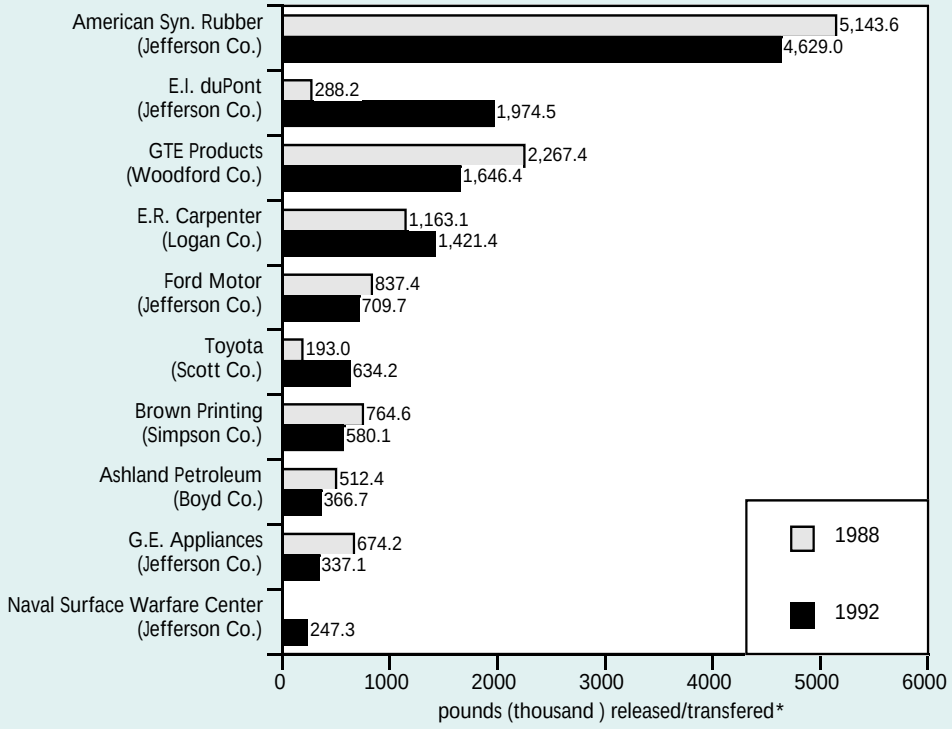


Note: Releases to the environment include air emissions, stream discharges (excluding those passed through publicly owned treatment works), underground injection, and on-site disposal in landfills, landfarming, and surface impoundments. Transfers for other types of disposal and treatment, and amounts sent for energy recovery and recycling are not included. 1988 data exclude chemicals delisted for reporting in recent years.
Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92.

The top ten facilities releasing toxics to the environment reported combined emissions of 49 million pounds in 1992. This reflects a 5.6% decrease in releases between 1988 and 1992. During that period, statewide releases from all reporting facilities declined more than 17%. The top ten facilities, located in seven counties, accounted for 70% of reported releases to the environment during 1992. E.I duPont, which reported the greatest releases in 1992, found a market for the acid it was injecting underground and eliminated its disposal in late 1992.

Figure 6

Top Ten Facilities Reporting Generation of Priority Toxic Chemicals in Kentucky



*Note: Includes releases and transfers for disposal or treatment. *Does not include priority toxics recycled or those chemicals used as a source of energy.*

Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Reports, 1988-92

Priority toxics include 17 chemicals targeted for reduction by the U.S. EPA due to high toxicity, carcinogenicity, or large volume releases with potential adverse impact on the environment. Ten facilities were responsible for 59% of the priority toxics reported released and transferred during 1992.

Figure 7

Releases/Transfers* of Priority Toxic Chemicals in Kentucky

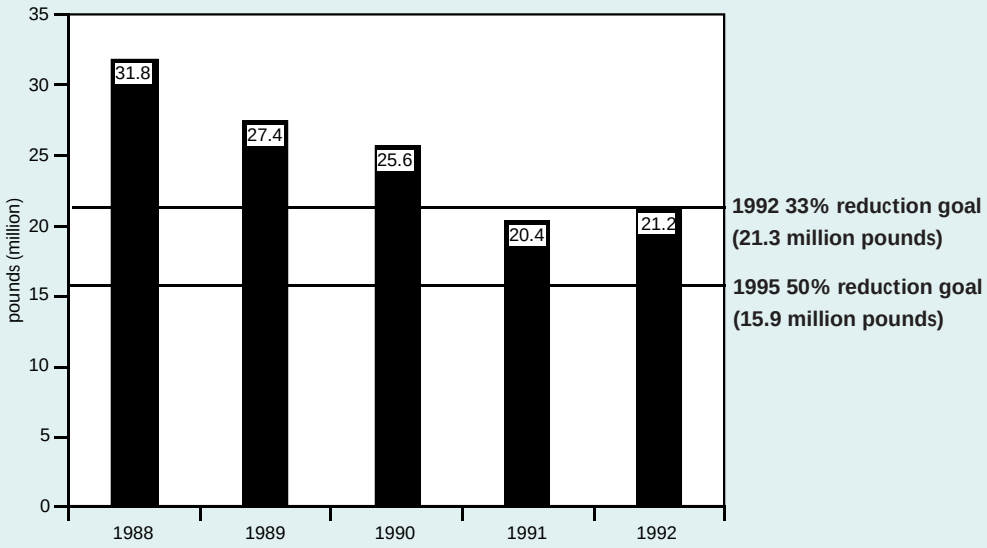
Priority Toxics (33/50) (thousand pounds)	1988	1992	% change (1988-92)
Benzene	549.1	284.3	-48.2
Cadmium	1.7	0.0	-99.1
Cadmium compounds	101.2	86.8	-14.3
Carbon Tetrachloride	30.9	12.8	-58.7
Chloroform	515.4	261.1	-49.3
Chromium	2,633.8	80.0	-97.0
Chromium compounds	296.0	172.9	-41.6
Cyanide/compounds	122.5	36.7	-70.0
Dichloromethane	1,536.9	2,021.0	31.5
Lead	778.4	20.8	-97.3
Lead compounds	695.1	259.7	-62.6
Mercury/compounds	12.2	12.0	-1.8
Methyl Ethyl Ketone	1,321.7	1,071.3	-18.9
Methyl Isobutyl Ketone	991.0	535.6	-46.0
Methyl chloroform	2,749.3	1,497.1	-45.5
Nickel	181.9	55.6	-69.4
Nickel compounds	215.1	291.7	35.6
Perchloroethylene	586.8	528.8	-9.9
Toluene	11,580.3	9,177.9	-20.7
Trichloroethylene	767.6	466.5	-39.2
Xylenes	5,657.0	4,286.8	-24.2
Total	**31,776.0**	**21,159.5**	**-33.4**

Note: Priority toxics are 17 chemicals prioritized for reductions by the U.S. EPA under its 33/50 Program due to high toxicity, carcinogenicity, or high volume of release with potential environmental impacts.
**Data includes releases and transfers for further treatment and disposal, and excludes transfers for recycling and energy recovery which were not required to be reported in 1988.*
Source: Kentucky Department for Environmental Protection, Toxic Release Inventory Report, 1988-92

Kentucky industries are making progress in reducing the generation of almost all of the priority toxic chemicals. For example, Ashland Petroleum in Boyd County reported a 50% decline in the generation of priority toxic chemicals between 1988 and 1992. The reductions were achieved through a variety of measures that focused on reducing leaks of benzene, toluene, and other solvents; phasing out the manufacturing of leaded gasoline; and eliminating heavy metals used in the facility's wastewater treatment plant. Atochem, in Marshall County, achieved a 62.3% reduction in releases and transfers of three chemicals: carbon tetrachloride, chloroform, and methyl chloroform between 1989 and 1992.

Figure 8

Reduction of Priority Toxic Chemicals in Kentucky



Note: Based on releases and transfers for disposal and treatment. Does not include transfers for recycling and energy recovery which were not required to be reported in 1988. The U.S. EPA's 33/50 Program has encouraged facilities to voluntarily reduce releases of priority toxic chemicals 33% by 1992 and 50% by 1995.

Source: Kentucky Department for Environmental Protection, Toxics Release Inventory Reports, 1988-92

Voluntary efforts to reduce the generation of 17 priority toxic chemicals have been successful in Kentucky. Indicators reveal that, through these efforts, the state has met the 1992 national reduction goal established for the U.S. EPA 33/50 Program that was designed to encourage voluntary efforts to reduce toxics. Kentucky passed a state law in 1994 promoting the further reduction of toxic and hazardous waste 25% by the year 1997 and 50% by the year 2002, using 1987 as the baseline.

Figure 9

Companies with Facilities in Kentucky Participating in the National Toxic Reduction Program

Facility, County	Facility, County
3M, Harrison Co.	Hoechst-Celanese Corp., Boone Co.
Aeroquip (Maysville Electric), Henderson/ Mason Co.	Inco Alloys International, Boyd Co.
Air Products & Chemical Inc., Marshall Co.	Ingersoll-Rand Co., Graves Co.
Akzo Coatings Inc., Jefferson Co.	Inland Container Corp., Jefferson Co.
Allied Inc., Franklin Co.	Interlake Conveyor Co., Bullitt Co.
American Air Filter Co., Jefferson Co.	International Knife, Saw, Kenton Co.
American Stand. (Trane), Jefferson/Fayette Co.	ISP Inc., Marshall Co.
American Synthetic Rubber, Jefferson Co.	ITW Inc., Logan Co.
Armco Steel Co., Boyd Co.	Johnson Controls (Johnson Cont., Trim Masters), Boone/Jefferson/ Nelson Co.
Armstrong Olean Tile Co., Hancock Co.	Kelley Tech. Coatings, Jefferson Co.
Ashland Petroleum Co., Boyd Co.	Kitchenaid Inc., Montgomery Co.
ATR Wire and Cable, Boyle Co.	Lexmark Intl., Fayette Co.
B.F. Goodrich (Tremco), Marshall/Jefferson/ Knox Co.	Mallinckrodt Specialty, Bourbon Co.
BASF Corp., Jefferson Co.	Modern Welding Co., Daviess Co.
Borden Inc., Jefferson Co.	National Southwire Aluminum, Hancock Co.
Cargill Inc., Marshall Co.	Norris Trim, Jessamine Co.
Collis Inc., Hardin Co.	Olin Corp., Meade Co.
Coltec Industries (Colt Industries), Warren Co.	Philips Lighting, Boyle/Madison Co.
Cooper Industries Inc. (Kirsch), Hardin/ Monroe/Wayne/Allen Co.	Phone-Poulenc Inc., Jefferson Co.
Dana Corp., Boyle Co.	Reynolds Metals Co., Jefferson Co.
Detrex Corp., Warren Co.	Rockwell International, Jefferson Co.
Donaldson Co. Inc., Jessamine Co.	Rohm & Haas Kentucky, Jefferson Co.
DOW Corning Corp., Carroll/Hardin Co.	Sealed Power Tech., Simpson Co.
E.I. duPont de Nemours & Co., Jefferson Co.	Sherwin-Williams, Madison Co.
Eaton Corp., Barron/Henderson/Warren Co.	SKF Inc., Barren Co.
Ebonite Intl., Christian Co.	SKW Alloys, Marshall Co.
Elf Atochem N. America, Carroll/Marshall Co.	Speed Queen, Hopkins Co.
Emerson Electric (Sweco, Therm-o-Disc, L'ville Ladder, Browning Mfg., Emerson.), Logan/Boone/Laurel/\rJefferson/Mason Co.	Tecumseh Products, Pulaski Co.
Engelhard Corp., Jefferson Co.	Texas Instruments Inc., Woodford Co.
Ernie Green Industries (Sun Mfg.), Grant Co.	Thomas Ind. Inc., Christian Co.
Florida Tile Industries, Anderson Co.	U.S. Department of Energy, McCracken Co.
Ford Motor Co., Jefferson Co.	Union Camp Corp., Shelby Co.
Gamco Products, Henderson Co.	United Catalysts Inc., Jefferson Co.
Gates Rubber Co., Hardin Co.	United Tech. Automotive, Union Co.
GE Electric (GE Appl., Worldsource Coil), Daviess/Fayette/Hopkins/Jefferson/Hancock	Valspar Corp., Jefferson Co.
General Motors Corp., Warren Co.	Vista Performance Polymers, Jefferson Co.
General Tires Inc., Graves Co.	Westvaco Corp., Ballard Co.
Goodyear Tire & Rubber Co., Hopkins Co.	Willamette Inc., Hancock Co.
	Woodwork Mid-America, Warren Co.

Source: U.S. Environmental Protection Agency, 1994

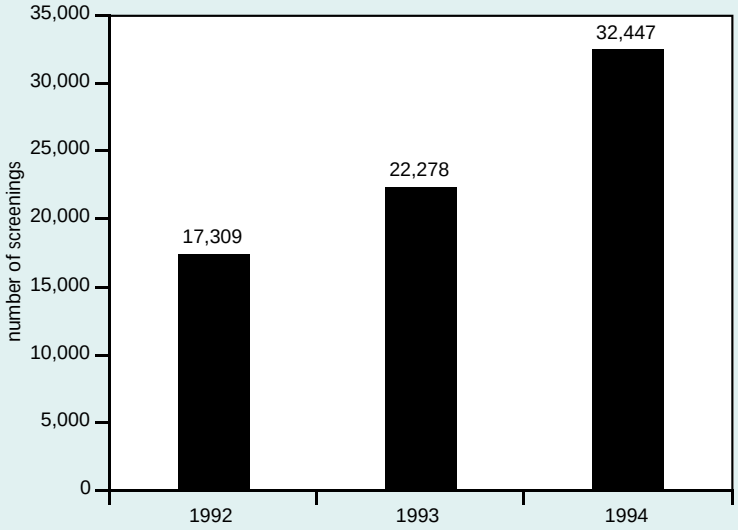
More than 100 parent companies with facilities in Kentucky participate in the national toxic reduction effort coordinated through the U.S. EPA 33/50 Program. The program encourages voluntary efforts to reduce the 17 priority toxic chemicals. Some participants have voluntarily made commitments to go beyond the goals of the program. Other facilities in Kentucky are also reducing the generation of toxics although not formally participating in the 33/50 Program.

II. Toxics and Health Indicators

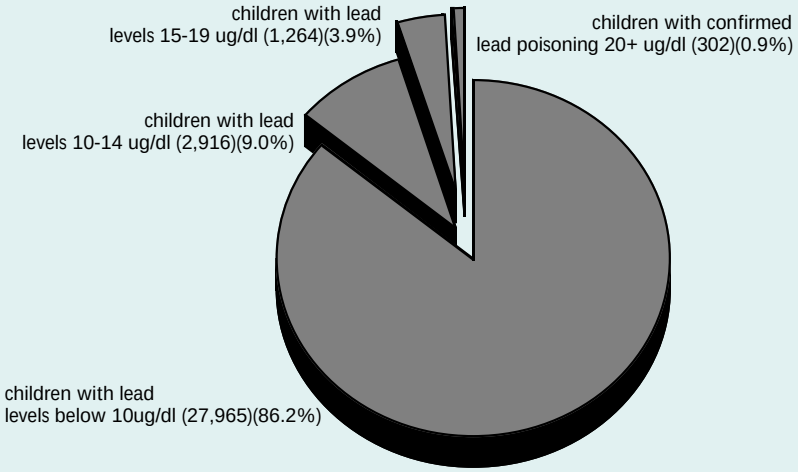
Figure 10

Blood Lead Monitoring in Kentucky Children

Number of Screenings for Lead in Kentucky Children



Blood Lead Levels (number of screenings) 1994



Note: Blood levels of 10 micrograms per deciliter of blood (ug/dl) are associated with adverse health effects and are cause for further testing and consultation with parents who are advised about ways to reduce exposure. Blood lead levels of 15 ug/dl trigger an environmental audit of the home and other potential exposure routes. Children with blood lead levels exceeding 20 ug/dl are considered to have lead poisoning that may result in developmental deficiencies and severe or fatal health effects. Some children are screened more than once.

Source: Kentucky Cabinet for Human Resources, 1994

An estimated 875,000 Kentucky homes contain lead-based paint. Of these, 17% are estimated to have young children considered at risk from lead exposure. State efforts to monitor blood lead levels in children have been focused on areas considered to be at the highest risk for lead exposure, including Jefferson, Fayette, Grant, Boone, Kenton and Campbell counties. Nearly 1% of the Kentucky children tested during the last three years were found to have lead poisoning (blood lead levels >20 ug/dL). Lead poisoning can result in severe and adverse health impacts. Another thirteen percent of the children tested during 1994 had lead levels high enough (>10 ug/dL) to cause decreased intelligence, reduced growth and learning disabilities. Children with high lead levels receive additional testing and assessment for exposure routes, as well as other assistance to help reduce exposure.

III. Lawn Care Chemical Indicators

Figure 11

Top 10 Lawn Care Chemicals Used by Commercial Applicators (1992)

Pesticide (active ingredient)	1992 (thousand pounds)
2,4-D	169.2
Pendimethalin	117.4
MCPP	33.4
MSMA	29.1
Fonofos	25.5
Glyphosate	24.2
Chlorothalonil	23.5
Fosamine Ammonium	19.2
MCPA	13.9
Oryzalin	10.5

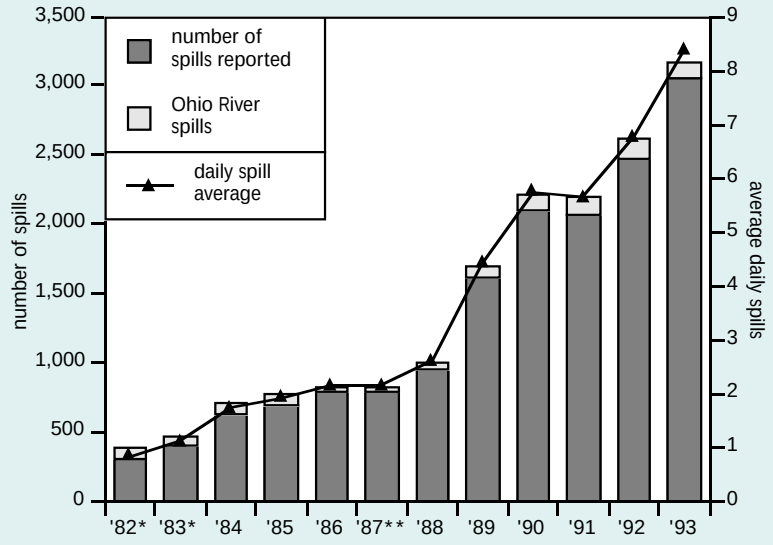
Source: Kentucky Division of Pesticides, 1994

Commercial pesticide applicators in Kentucky reported using 598,000 pounds of active pesticide ingredients for lawn care purposes during 1992. These applicators include commercial lawn care companies and larger golf courses. The survey, conducted by the Division of Pesticides during 1993, was not completed so data can not be compared to previous years. Diazinon, which has been recently detected in Lexington's sewer system, was listed as one of the top ten chemicals used for lawn care purposes in the partial survey done during 1993.

IV. Toxic and Hazardous Spill Indicators

Figure 12

Spills of Toxic and Other Hazardous Materials in Kentucky



Note: Includes spills of toxic and hazardous materials reported to the state and other agencies. Estimates from records. **Federal SARA Title III ("Community Right to Know Act") signed into law.*
Source: Kentucky Department for Environmental Protection; Ohio River Valley Sanitation Commission, 1994

Spills of toxic materials caused several highly publicized emergencies in recent years. A spill of ethylene dibromide along the entire length of the Ohio River shut down public drinking water systems in several Kentucky communities during 1994. Lexington experienced two spills requiring evacuations and business closings during that year. One spill involved a hydrochloric acid leak which formed a toxic plume that spread out over parts of the city. Just days later, a leaking cylinder of sulfur dioxide forced evacuation of 300 people and closed adjacent businesses. These episodes and similar ones occurring statewide along transportation routes and in areas of high industrial activity continue to pose threats to area residents and the environment.

Chapter 5

Natural Resources

Natural Resources

The state's farmlands, forests, and wildlife contribute greatly to our economic and ecological well-being. The future of these resources will be dictated by our ability to manage them in a sustainable manner.

This chapter reviews the state's progress toward managing and protecting our natural resources so future generations will continue to receive the benefits these resources provide. Indicators are included to measure the health and productivity of our farms, the sustainability of our forests, and the diversity of Kentucky's wildlife and natural areas.

I. Agriculture Indicators

During the past year, attention has been intently focused on issues surrounding tobacco, Kentucky's top cash crop, and its future production in the state. Tobacco and other products produced on 91,000 Kentucky farms generated $3.38 billion in sales during 1993, up 5% since 1992. A consortium of government and agriculture interests hope to raise this to $5 billion by the year 2000.

Prime Farmland. Meeting this goal will hinge on maintaining and expanding markets while producing high quality agricultural commodities in a sustainable manner. Farmlands presently cover about 56% of the state's land area. About 34% is considered prime—lands best suited for the production of crops and livestock. Indicators reveal that prime cropland continues to be converted to other uses, with 6% lost between 1987 and 1992.

Efforts to halt the loss of historic horse farms and other agricultural lands resulted in the passage of a program called PACE (Purchase of Agriculture Conservation Easements) in 1994. The program, which has yet to be funded, promotes farmland protection through local planning and by the purchase of conservation easements.

Soil Erosion. The erosion of top soil can greatly affect farmland productivity while also degrading water quality in streams and rivers. The use of conservation tillage, a plowing technique that disturbs less soil, on three million acres of cropland, has resulted in a dramatic reduction of soil loss. Erosion rates declined from an average of 8.4 tons per acre a year in 1987, to 5.3 tons in 1992.

The setting aside of 27% of the state's 1.4 million acres of highly erodible farmland under the federal Conservation Reserve Program has also assisted in reducing soil erosion. However, the U.S. Soil Conservation Service estimates that half of the state's crop and pastureland is still in need of erosion control measures.

Livestock Waste. A recent survey by state conservation districts revealed that 57% of the 5,813 livestock farms are in need of a waste management system. Another 16% of the operations with waste systems need improvement. Animal waste is contributing to pollution problems in a number of streams, making them unfit for swimming and

Highlights

Agriculture

- Kentucky's 91,000 farms generated $3.38 billion in product sales during 1993, up 5% since 1992.
- Between 1987 and 1992, the state lost 6% of its 3.4 million acres of prime cropland to other uses.
- Soil erosion from croplands was reduced from an average 8.4 tons/acre/year in 1987 to 5.3 tons in 1992.
- More than half of the livestock farms in the state still need animal waste management systems.
- Testing of Kentucky-grown produce in 1993 revealed only 3% of the 134 samples had pesticide residues, and levels were well below the health-based standards.

Forests

- More than 1,000 wood industries generate $1.8 billion in sales annually. However, a significant amount of logs and raw lumber is shipped out-of-state for processing losing valuable jobs and revenue.
- Growing demand for mixed hardwoods led to a 45% increase in timber stumpage prices in the state between 1992 and 1993.
- Less than 10% of state's 440,000 private forest owners have received technical assistance with forest management.
- Forest fires have contributed to a decline in timber quality. In 1993, 50% of the 1,025 forest fires were purposely set and 31% were caused by carelessness.

Wildlife

- The deer population appears stabilized at 380,000 in 1993. Deer herds were once reduced to 2,000 in the 1940's due to unregulated hunting.
- An estimated 3,800 species of plants, mussels, fish, mammals, amphibians, and reptiles are found in the Commonwealth. About 12% are considered rare.
- 37 of the 895 federally-listed threatened and endangered species in the U.S. occur in Kentucky.
- Less than 1% of the state's land has been set aside to protect natural habitats. A state fund was established in 1994 to purchase natural areas and preserve Kentucky's natural heritage.

other uses. The Division of Water currently regulates water discharges at 878 farm waste management operations. The Kentucky Soil Erosion and Water Quality Cost-Share Fund, created in 1994 and financed by an increase in registration fees on pesticide manufacturers, will provide farmers with cost-share funds to improve waste management systems and implement practices to reduce soil erosion and prevent water pollution from farmland.

Agricultural Chemicals. The increased productivity of farmlands is attributed to the use of agricultural chemicals. While agricultural pesticides and fertilizers have assisted in producing larger harvests on fewer acres of land, their use can also pollute nearby streams or leach into underground sources of water.

The sale of fertilizer in Kentucky is on the upswing after declining trends in the 1980's. In 1993, 958,000 tons of fertilizer was sold in the state, according to Kentucky Agricultural Statistics Service. Sales of pesticides for use on farms in Kentucky has been fairly constant since reporting began in 1990. In 1993, 4,640 tons of active pesticide ingredients were sold in the state.

Pesticide and nitrate contamination is increasingly being detected in waterways throughout the Commonwealth. For example, the Louisville Water Company has detected various agricultural chemicals in its raw water supplies from the Ohio River. The University of Kentucky and others found detectable levels of agricultural chemicals in the 4,859 private drinking water wells tested during the past few years, although only a small percentage exceeded drinking water standards. Farmers will be required, over the next two years, to develop pollution prevention plans to protect groundwater from chemical contamination under a state law passed in 1994.

Food Safety. Public concern about pesticides in food has led to greater scrutiny of 85 chemicals commonly used on crops. The U.S. Environmental Protection Agency announced it will review the health risks of these pesticides during the next five years. Eight of the chemicals are widely used in Kentucky.

Random tests of Kentucky-grown produce for pesticide contamination have revealed that, of the 134 samples tested in 1993, only three percent had trace levels of pesticides detected. The pesticide levels were well below the current health-based standards for those chemicals.

II. Forest Indicators

Kentucky's forests are coming under increasing harvesting pressure as demand for wood products grows and shifts occur in the timber resource base from the Pacific Northwest to the South. It is estimated that in ten years the South will produce half of the nation's lumber.

Debate about how best to take advantage of these expanding markets while ensuring the diversity and sustainability of our forests began two years ago when a chip mill proposed to locate in Western Kentucky. Public protest led to the withdrawal of the chip mill proposal. However, the issue pushed forests to the front of the state's economic and environmental agenda.

Forest Industry. Kentucky is now engaged in discussion of how best to manage its forests both for long-term economic benefits and ecological health. The wood industry contributes significantly to the state's economy, generating $1.8 billion in sales annually. Presently, more than 1,000 wood-related industries, many of which are small sawmills, are located in 105 counties.

A significant amount of the timber harvested (some estimate up to 70%) is shipped out-of-state as logs or raw lumber for processing, resulting in the loss of valuable jobs and revenue. State lawmakers, recognizing the value-added potential for Kentucky's wood industry, passed two measures in 1994 to promote its development. The Forest Products Council was established to develop the wood industry in a manner consistent with sustaining the productivity of forest resources and their watersheds. The Wood Products Competitiveness Council will focus on incentives and networks to promote, enhance, and develop the secondary wood industry.

Forest Management. Nearly 93% of the state's forestland is privately owned. An estimated 140,000 acres of forestland are logged each year in Kentucky, 95% of which is on private lands. Inadequate forest management and poor logging practices have affected timber quality throughout the Commonwealth. Currently 70% of the annual timber growth statewide is occurring in lower grade trees, according to a U.S. Forest Service assessment.

Federal and state government programs aimed at assisting landowners manage their forestland have been ongoing for many years. But, to date, less than ten percent of the 440,000 forestland owners in Kentucky have received technical assistance on how best to manage their land for timber and other uses.

Poor logging practices have also impacted timber quality. The Master Logger Program, established in 1993, is a joint initiative between the Division of Forestry, the forest industry, and universities to promote proper timber harvesting practices. To date, 290 loggers have been trained through the program.

The lower quality of timber resources is also a result of forest fires. Arson is now the leading cause of forest fires in the state. While efforts to prosecute arsonists and educate the public about the impacts of forest fires have long been a high state priority, fire remains a significant forest threat.

A Forest Summit was convened by Governor Brereton Jones in 1994 to bring together various interests to discuss the future of Kentucky's forests. Among the issues raised were the need for continued dialog and strong partnerships among government, universities, industries, public interest groups, and landowners to promote sustainable forests;

additional knowledge of forest ecosystems; a targeted strategy to promote the forest industry as well as forest tourism opportunities; and landowner incentives for forest ecosystem management.

Public Forestlands. Management of Kentucky's only national forest has received increased attention, primarily in regard to timber production and harvesting methods. The Daniel Boone Forest is comprised of nearly 700,000 acres in 22 counties. About 4,000 acres are logged each year producing, on average, 350 million board feet of timber.

The U.S. Forest Service has moved away from clearcutting, which removes trees in a blocks of 1 to 40 acres, to "shelterwood" as its primary harvesting method. This method leaves a certain number of trees per acre. Despite this change, almost every timber sale in the past year has been administratively challenged by a public interest group opposed to logging in the forest.

The U.S. Forest Service is currently in the process of revising its 10-year management plan for the Daniel Boone. The plan will consider logging, off-road vehicle use, recreation, ecosystem management, and other management issues related to the forest.

A similar debate is also occurring at Land Between the Lakes, a 170,000 acre reserve between Lake Barkley and Kentucky Lake that is owned by the Tennessee Valley Authority. The agency is finalizing an environmental impact statement that addresses logging, recreational, and other forest uses at Land Between the Lakes.

Urban Forestry. With 52% of Kentucky's population now living in urban settings, more communities are establishing urban forestry programs. To date, 74 cities have established forest programs. The City of Mayfield Tree Board and the Chamber of Commerce Beautification Committee have initiated a multifaceted effort to improve the community through tree planting and stricter enforcement of litter and illegal dumping ordinances and sign codes. As a result, Mayfield has enticed new businesses to move into the community.

Another example of a tree planting partnership is T-FORCE, in Jefferson County. The program provides students an opportunity to improve their community by planting 1,600 yard and 500 street trees donated by the Louisville Gas & Electric (LG&E) Company. The partners, which include LG&E, Louisville Conservation Resources Council, Division of Forestry, Louisville Central Development Corp. and the Metropolitan Sewer District, have proposed to plant up to 3,000 trees annually in the city and county.

III. Wildlife Indicators

Indicators measuring wildlife populations and the number of rare species in this chapter provide a general but incomplete picture of ecological health. A full assessment of the state's biological diversity will require a more careful analysis of all species and the ecosystems they inhabit. A Biodiversity Task Force, composed of a wide range of interests, was established by Governor Brereton Jones in 1993. The group will assess the status and develop a strategy to conserve the state's natural diversity.

Wildlife Populations. The national bird breeding survey reveals that of the 94 bird species assessed in Kentucky, 27 are declining in population while 25 species are increasing. These trends indicate that many species of birds in the state are undergoing population changes due to a number of variables. In some cases, the change is significant enough to warrant concern.

The steady decline of ducks and geese, for example, has brought about greater federal and state measures to protect wetlands, which serve as important breeding grounds for waterfowl. And multi-state and regional projects to better assess songbird populations and adjust or develop ecosystem management strategies have been undertaken in Central Kentucky, the Daniel Boone National Forest, and Mammoth Cave.

The Kentucky Department of Fish and Wildlife Resource has initiated several programs to restore various species of wildlife. A deer restoration program has resulted in a sustainable population of 380,000 in 1993, compared to 2,000 in the 1940's. Other restoration efforts include wild turkey and, most recently, river otters. Since 1991, 355 otters have been released at 14 sites to restore populations.

But illegal hunting continues to affect deer and other wildlife populations in Kentucky. In 1993, the Department of Fish and Wildlife Resources issued 7,319 citations and collected $141,990 in fines for violations related to hunting and other activities. The record number of violations indicates that poaching still remains a significant problem.

Fish and Mussels. Monitoring populations of various species of fish provides a general indicator of the water quality of streams, rivers, and lakes. Populations of some environmentally sensitive species of fish, such as paddlefish and sauger, are increasing in some areas of the Ohio River—an indication that water quality is improving.

The recent return of cavefish to the South Branch of the Hidden River also signals progress in cleaning up polluted waterways. The cavefish were driven out by sewage and industrial pollutants discharged by a local wastewater treatment plant. The treatment plant has since been upgraded to meet environmental standards improving water quality in the watershed.

The commercial harvesting of fish and mussels remains an important industry in the Commonwealth. In 1993, three million pounds of mussels were harvested at a value of $5 million. And sport fishing is still one of the most popular past times in the state with 562,605 fishing licenses sold in 1993. Kentucky is also considered to have one of the largest private pay lake industries in the country with an estimated 120 commercial pay lakes. Many of the 40 to 50 aquaculture operations in the state sell pond-

raised catfish or trout to these pay lakes.

Although progress in restoring water quality and certain fish populations has been made, 28% of the assessed waterways still cannot fully support aquatic life or other uses due to pollution. Fish consumption advisories also remain in effect along 859 miles of streams and rivers, one lake, and five ponds due to the accumulation of toxic chemicals in fish.

Threatened and Endangered Species. The protection of rare species has recently become a hotly-debated topic, fueled by the federal government's effort to protect the Northern Spotted Owl in the Pacific Northwest. The "jobs versus preservation" debate has focused much attention on the need to better manage and protect habitats in a more proactive manner to prevent species loss.

Species become endangered due to a number of reasons. However, development and other human activities have dramatically increased the rate of worldwide extinction. With each species loss, the diversity and complexity of life on earth is diminished, altering the balance of nature.

Of the 895 species listed as threatened or endangered in the U.S., 37 are found in Kentucky. Another 66 species occurring in the state are proposed for listing under the federal Endangered Species Act of 1973. Once listed, the law prohibits anyone from harassing, capturing, or killing a protected species. The act also provides guidelines for the recovery of listed species.

Native mussels are still considered to be among the most threatened species in the state. The damming of free-flowing rivers and water pollution have greatly affected mussel populations. Nineteen of the 103 species native to Kentucky are extinct or have been extirpated from the state. Of the remaining 84 species, 35 are considered rare.

The exotic Zebra Mussel poses an additional threat to native species. These mussels not only clog water supply intake valves, but experts predict the Zebra Mussel may eliminate the state's native mussel fauna by encrusting them. Zebra Mussels have been found in the Ohio River, Lake Barkley, Kentucky Lake, the Lower Cumberland River, the Mississippi River, Taylorsville Reservoir, and the Green River Basin. Preventing the spread of Zebra Mussels, better monitoring of rare mussels, and setting aside undisturbed habitat is critical to the survival of native mussel species.

Habitats. Some of the state's rare animals, such as the bald eagle, the black bear, bobcat, badger, the swamp rabbit, and some species of bats are increasing due to the protection and management of certain habitats. A proposal to set aside 20,000 acres of pine forest in the Daniel Boone National Forest to protect the habitat of the endangered Red-Cockaded Woodpecker is under consideration by the U.S. Forest Service. The agency has also adopted a policy to restrict logging along 2,300 miles of clifflines in the Daniel Boone National Forest to protect bat caves.

But the recovery of endangered species is often difficult. Many believe that more preventative measures, which include the identification and protection of critical habitats, are a more effective approach to addressing the problem of species extinction. However, less than 1% of the state's land, 156,093 acres, has been set aside to preserve wildlife habitat. Only 18% of these lands are protected for rare species habitat. These protected lands include 30 state nature preserves.

Other lands that provide important habitat include 74 state wildlife management areas, national forest and park lands, and land owned by conservation groups such as the Kentucky Nature Conservancy. The Department of Fish and Wildlife Resources also manages 120,740 acres of private land for wildlife habitat.

The private sector has become increasingly involved in establishing wildlife habitat. In 1994 the University of Kentucky and Cyprus Realty Co., a subsidiary of Cyprus Amax Coal Co., agreed to establish a 31,000 acre wildlife management area. The agreement would join the university's Robinson Forest with a neighboring 16,000 acre tract that belongs to Cyprus, creating one of the largest wildlife management areas in Kentucky.

Wetlands are among some of the most biologically diverse ecosystems providing habitat to one-third of the federally-listed species in Kentucky for some portion of their lifecycle. A recent state inventory revealed that, of the original 1.6 million acres of palustrine wetlands, 323,918 acres remain. The Kentucky Department of Fish and Wildlife Resources currently manages 33,000 acres of wetlands for waterfowl habitat. Among those wetlands is the 3,200 acre Columbus Bottoms Wildlife Management Area set aside by the Westvaco Corporation in 1992. Located along the Mississippi River, the area is managed primarily as habitat for migrating waterfowl including mallard, wood duck, and Canada goose.

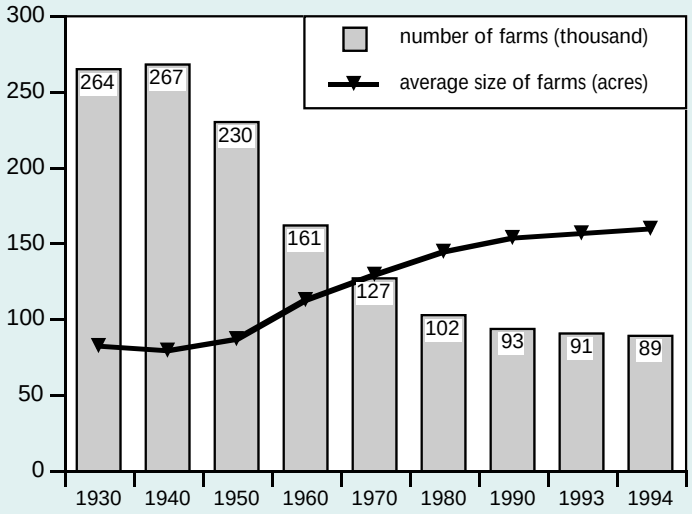
The inventory of rare species is essential to identifying critical habitats and is the focus of the National Biological Service. The Kentucky State Nature Preserves Commission was recently awarded a grant under the federal program to assist with its inventory of rare plants. To date, 20 counties have been inventoried for rare plants and animals. Inventories are underway in 36 other counties. This information will assist in developing a rare plant list.

The conservation of critical natural habitats has progressed slowly in Kentucky. Monies to purchase land has been primarily generated through a state income tax checkoff. But in 1994, the Kentucky Legislature passed landmark legislation to provide, for the first time, a permanent source of funds to purchase critical wildlife habitats from willing sellers. The Heritage Land Conservation Fund, financed by coal severance tax proceeds, a portion of environmental fines and penalties, and sales of a speciality license plate, will generate an estimated $5 million annually for land purchases.■

I. Agriculture Indicators

Figure 1

Number and Average Size of Farms in Kentucky

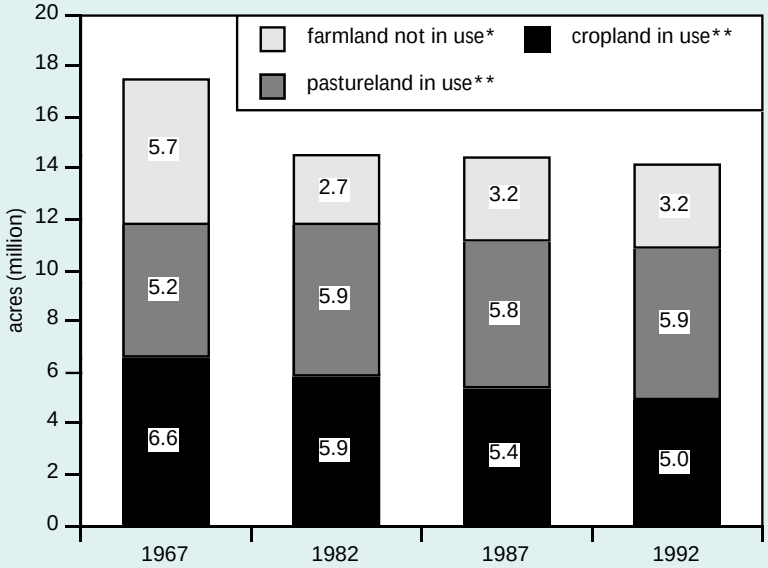


Note: Definition of farm, changed in 1975, defined as a place that sells or could sell $1,000 of agricultural products during the year.
Source: Kentucky Agricultural Statistics, 1994

The number of Kentucky farms dropped by another 2,000 since 1993 and now total 89,000. Farmlands presently cover 56.4% of the state's 25.4 million acres of land. About 76% of the farms are small family-owned operations ranging from one to 179 acres. Kentucky currently ranks fourth in the nation in the number of farms, following Texas, Missouri, and Iowa.

Figure 2

Crop and Pastureland Acreage in Kentucky

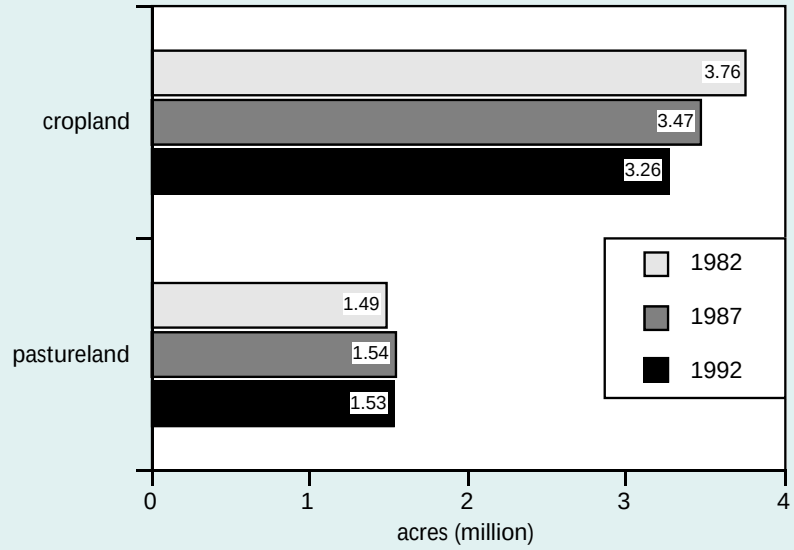


Note: Farmland is defined as a place that sells or could sell $1,000 of agricultural products during the year.
*Source: *U.S. Department of Agriculture National Agriculture Statistics **U.S. Department of Agriculture Soil Conservation Service, National Resource Inventories, 1967, 1982, 1987, 1992*

Kentucky farm products generated $3.38 billion in 1993, up 5% since 1992. Livestock and related products accounted for 51% of the total cash receipts, with crop sales making up the remainder. In 1993, the cattle and calf inventory totaled 2.6 million, unchanged from the previous year, which was the largest inventory since 1984. Farmers also rebounded from the drought of 1991 to produce record levels of corn in 1992, and the largest production levels of tobacco, soybean, and wheat in 10 years. Those levels, however, declined somewhat in 1993 due to a dry, hot summer and flooding along the Mississippi River.

Figure 3

Prime Farmland in Kentucky



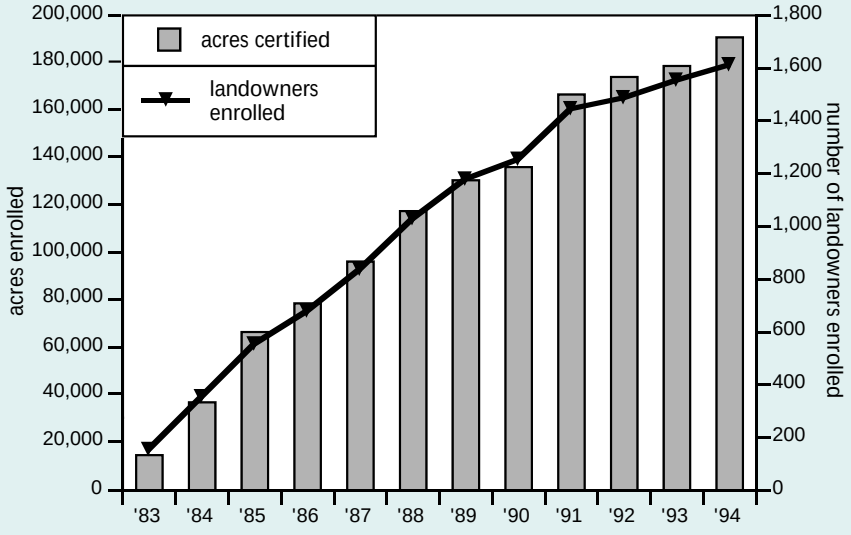
Note: Prime farmland defined as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses.

Source: U.S. Department of Agriculture, National Resources Inventories, 1982, 1987,1992

About 34% of the state's farmland is considered "prime." Prime farmland is flat or rolling acreage susceptible to little or no erosion. It produces the most food, feed, fiber, and forage with the least amount of fuel, fertilizer, and labor. Between 1987 and 1992, 6% of the state's prime cropland was converted to other uses.

Figure 4

Number of Landowners and Acres Enrolled in Agriculture District Program to Protect Farmlands in Kentucky



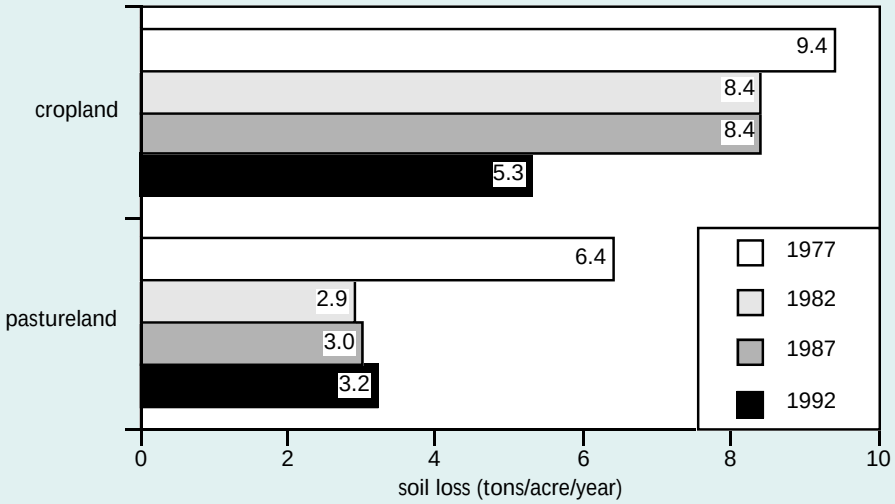
Note: Cumulative yearly totals for number of landowners and acres enrolled in the program.

Source: Kentucky Division of Conservation, 1994

The Agricultural District Act was created in 1982 to protect prime and other farmland from development. Since then, 1,627 landowners, and 191,428 acres of farmland in 44 counties have been enrolled in the voluntary program. The advantages of participating in the program are lower property taxes and protection from annexation when cities expand into rural areas.

Figure 5

Average Farmland Soil Erosion Rates in Kentucky

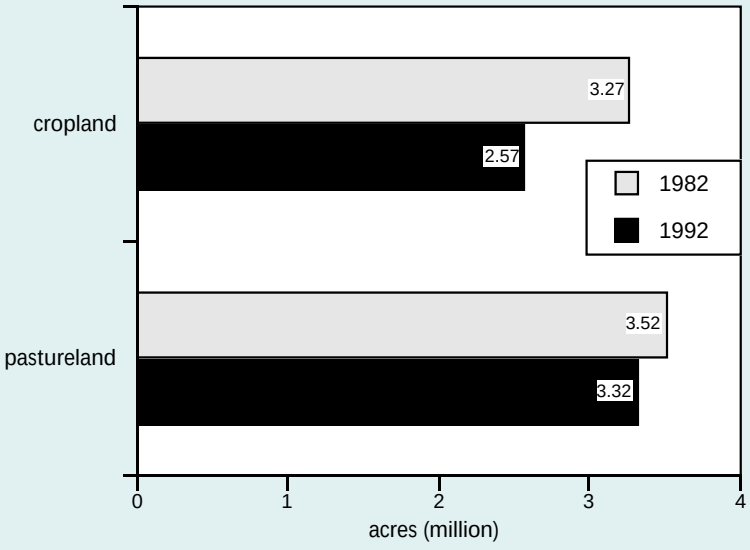


Source: U.S. Department of Agriculture, National Resource Inventories, 1977-1992

The loss of soil from farms not only impacts its productivity but can impair water quality. While farmers have reduced soil erosion rates significantly since 1977, sedimentation from farmlands and other sources is still the second leading cause of water pollution in Kentucky. In 1992-93, contaminated runoff from farmlands was impairing 980 miles of rivers and streams monitored in seven of river basins compared to 864 miles in 1990-91.

Figure 6

Kentucky Farmland in Need of Erosion Control Measures

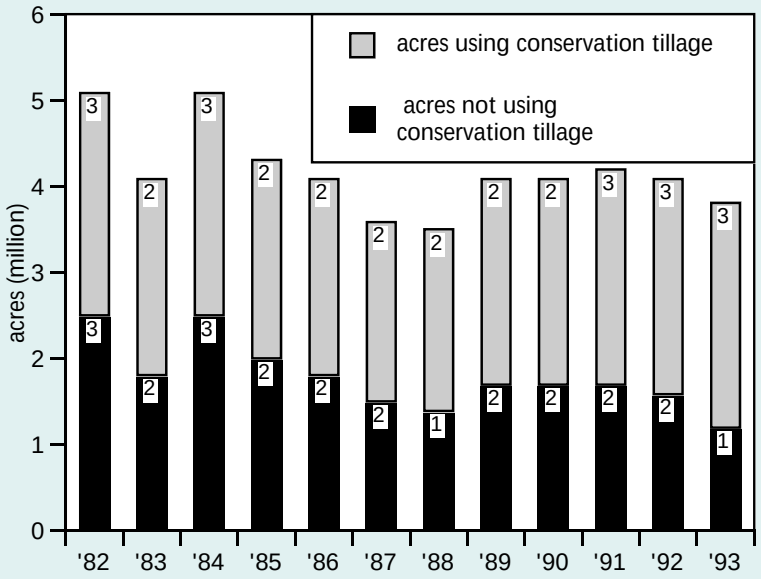


Source: U.S. Department of Agriculture, National Resource Inventories, 1982-92

Half of Kentucky's crop and pastureland is still in need of erosion control measures. The federal Conservation Reserve Program has assisted in retiring 379,109 acres of the state's 1.4 million acres of highly erodible farmlands. Farmers are paid to set aside their land from production for a certain length of time to reduce erosion. Almost $22 million has been paid to Kentucky farmers to retire highly erodible farmland from production since the program began in 1986.

Figure 7

Conservation Tillage Use on Cropland in Kentucky



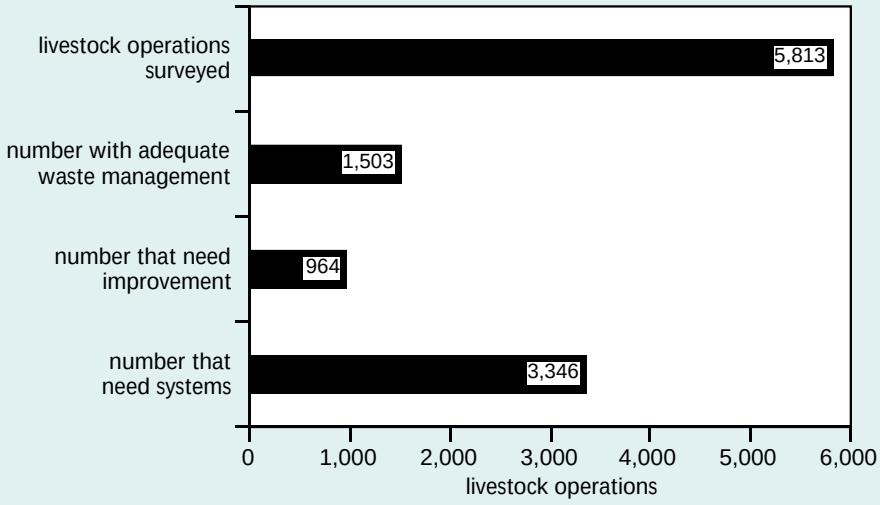
Note: The federal government classifies a farm to be in conservation tillage when at least 30% of the residue from the previous year's crop is left on the ground.

Source: Conservation Tillage Information Center, Kentucky Division of Conservation, 1994

Kentucky continues to lead the nation in the percentage of cropland in conservation tillage, a group of plowing techniques that disturb less soil and reduce erosion. According to state conservation officials, 68% of the state's planted cropland acreage in 1993 used conservation tillage practices to reduce soil erosion.

Figure 8

Livestock Waste Management Status in Kentucky (1993)

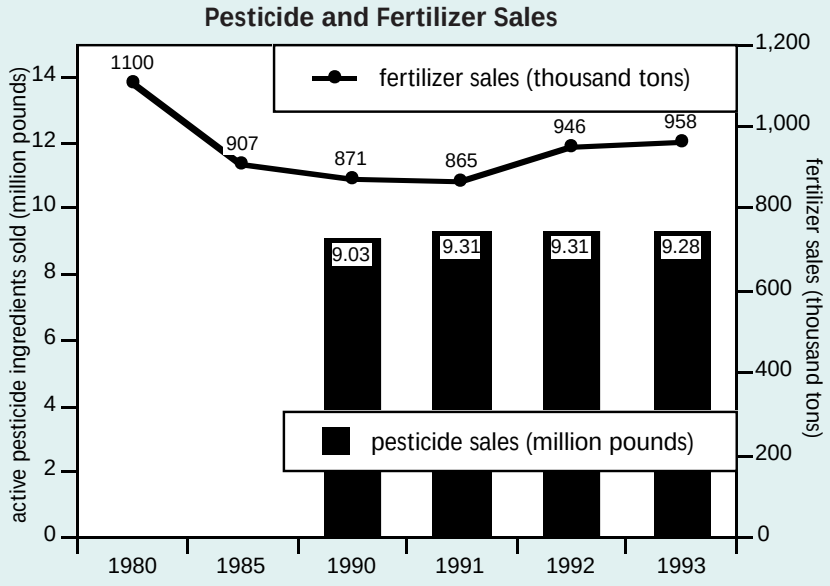


Source: Kentucky Conservation Districts Survey, 1994

The management of animal waste generated by a 1993 statewide livestock inventory of 2.4 million head of cattle, 850,000 hogs and pigs, 27,000 sheep, and 3.48 million chickens is a significant challenge. Of the 5,813 livestock farms, 57% are in need of a waste management system. The Soil Erosion and Water Quality Cost-Share Fund, passed by the General Assembly in 1994, will help farmers improve livestock waste management systems and implement practices to control runoff pollution.

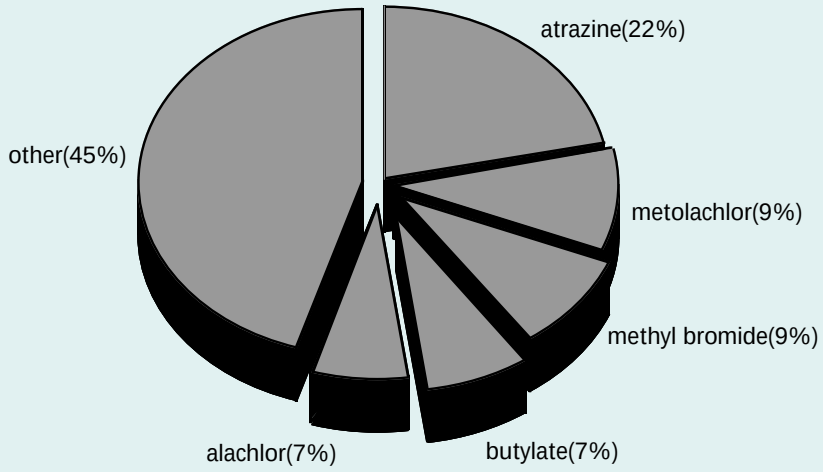
Figure 9

Agricultural Chemical Sales in Kentucky



The use of agricultural pesticides and fertilizers have increased crop yields significantly. However, these chemicals can also run off the land and pollute nearby waterways. Trends reveal that the sale of agricultural pesticides has remained fairly constant with little to no overall reduction in use during the past four years. The use of nitrogen-fertilizers is on the upswing after declining trends in the 1980's and early 1990's.

Pesticide Sales—Top Five Active Ingredients (1993)



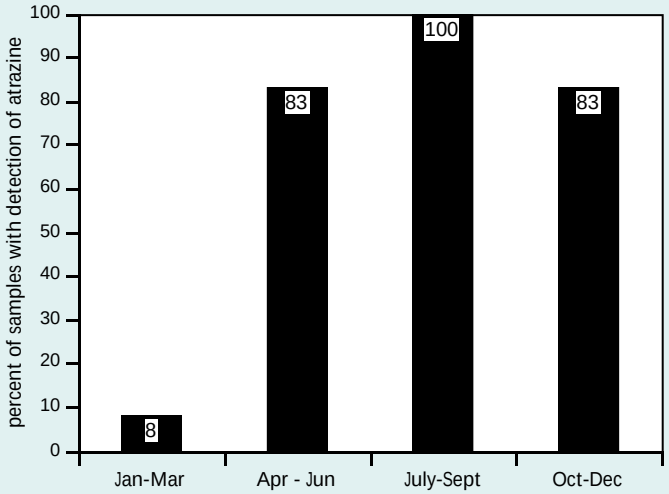
About 75% of the agricultural pesticides sold in Kentucky during 1993 were herbicides. Atrazine is the most commonly used herbicide in the state, followed by metolachlor. Both of these chemicals are extensively used in corn production. The sale of these chemicals increased about one to two percent in 1993 compared to 1992.

Note: Data on pesticide sales prior to 1990 not available. Pesticide sales by type in 1993 were herbicides (74%), fumigants (10%), insecticides (8%), plant growth regulators (6%), fungicides/antibiotics (2%).

Source: Kentucky Division of Pesticides, Kentucky Agricultural Statistics Service, 1994

Figure 10

Detection of Atrazine in the Ohio River at Louisville (1993)*

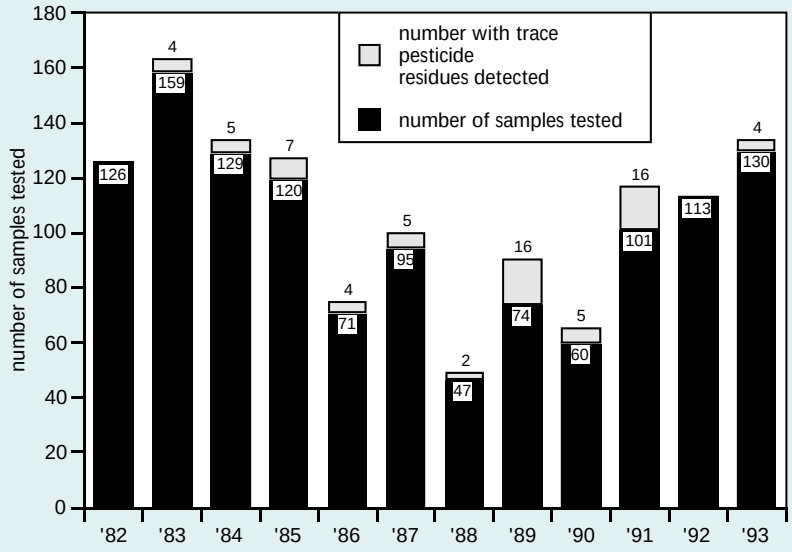


**Water samples taken from Ohio River mile posts 594.5 & 600.6 in 1993.*
Source: Ohio River Valley Water Sanitation Commission, Assessment of Water Quality Conditions, Ohio River Main Stem, 1992-93

Varying levels of the widely-used herbicide Atrazine have been detected in the Ohio River and some of its tributaries as well as in Louisville's public drinking water supplies. Additional testing for pesticides in public drinking water is currently underway in Kentucky to identify potential contamination problems.

Figure 11

Pesticide Testing of Fruits and Vegetables Grown in Kentucky



Note: Food samples are screened for parts per billion of chlorinated pesticides and .05 parts per billion of organophosphates. If other contaminants are suspected, additional analysis is conducted.
Source: Kentucky Cabinet for Human Resources, 1994

Produce grown in Kentucky is randomly tested for various pesticides. In 1993, three percent of the 134 samples tested had detectable pesticide residues. However, levels were well below health-based standards. Public concern about food safety has led the U.S. EPA to review 85 pesticides for cancer and other health risks. Eight of the pesticides under review—atrazine, alachlor, acephate, cyanazine, pendimethalin, trifluralin, simazine, and 1,3-dichloropropane—are widely used in Kentucky to grow crops such as corn, soybeans, and tobacco.

II. Forest Indicators

Figure 12

Wood Industries in Kentucky

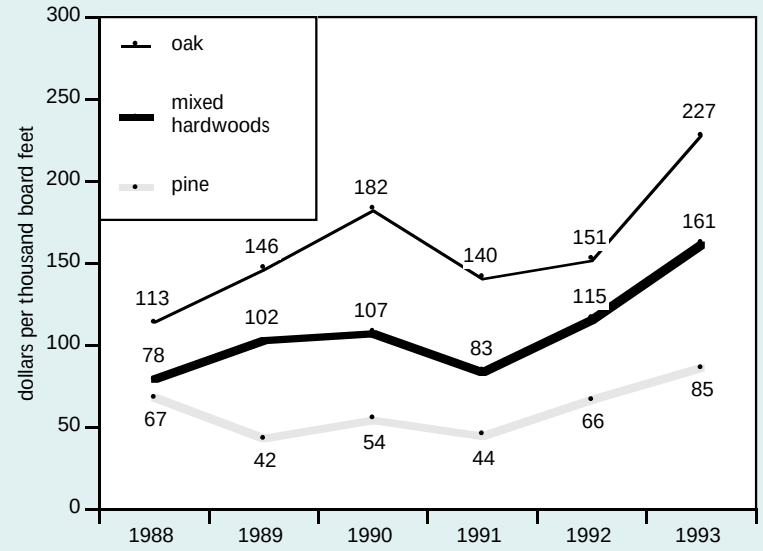
Note: Primary wood industries such as sawmills and paper mills process logs into materials . Secondary wood industries manufacture a product from wood materials such as furniture and paper.

Source: Kentucky Division of Forestry, 1994

Kentucky's wood industries contribute greatly to the state's economy, generating $1.8 billion in sales annually. However, a significant amount of timber harvested is shipped out-of-state for processing. The amount of value-added potential that is lost through the interstate shipment of logs and raw lumber is unknown, but thought to be substantial. In 1994, the General Assembly created the Wood Products Competitiveness Council and the Wood Products Council to promote the forest industry in Kentucky.

Figure 13

Timber Stumpage Price Trends in Kentucky



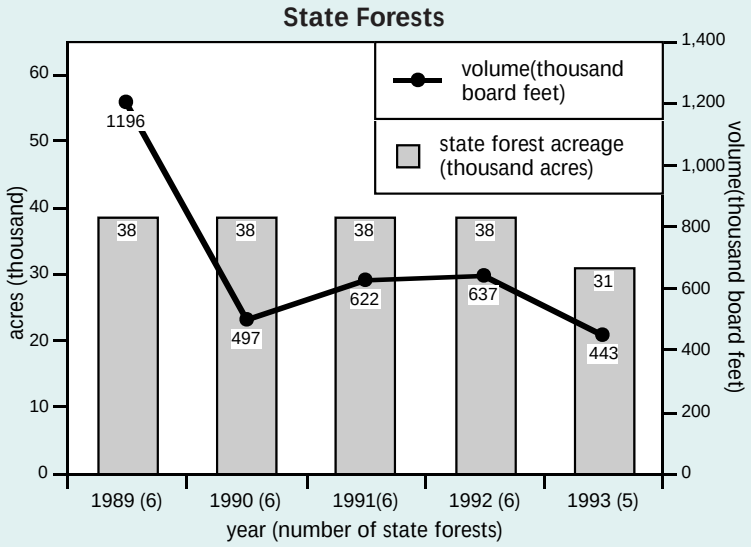
Note: The timber market is very complex and prices vary greatly by set factors such as species, size, grade, and markets. The prices provided are on average prices for delivered logs purchased in Kentucky.

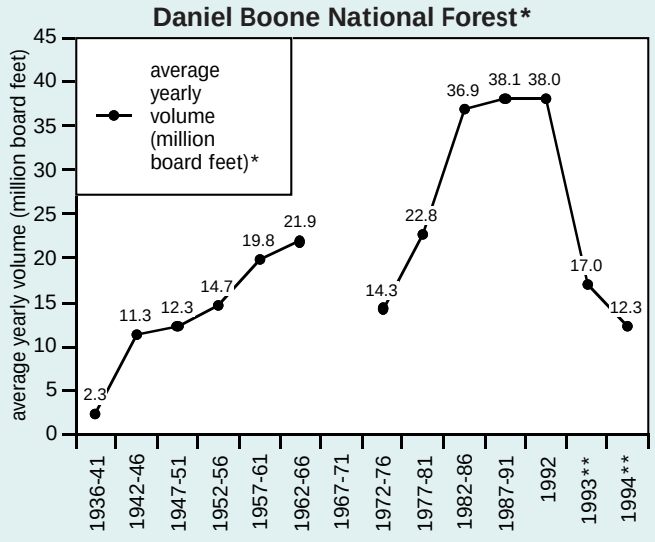
Source: Timber Mart-South, Stumpage Price Mart; University of Kentucky School of Forestry, 1994

Many experts predict that timber production will increase in Kentucky as the resource base shifts from the Pacific Northwest to the South and from public to private forestland. The most tangible evidence of this shift to is the steady increase in timber stumpage prices. Stumpage prices for mixed hardwood sawtimber rose 45% from January 1992 to July 1993. The U.S. Forest Service predicts that demand for hardwoods will increase 25%, plywood 50%, and paper and other products 100% by the year 2004.

Figure 14

Timber Harvests from Selected Public Forests in Kentucky





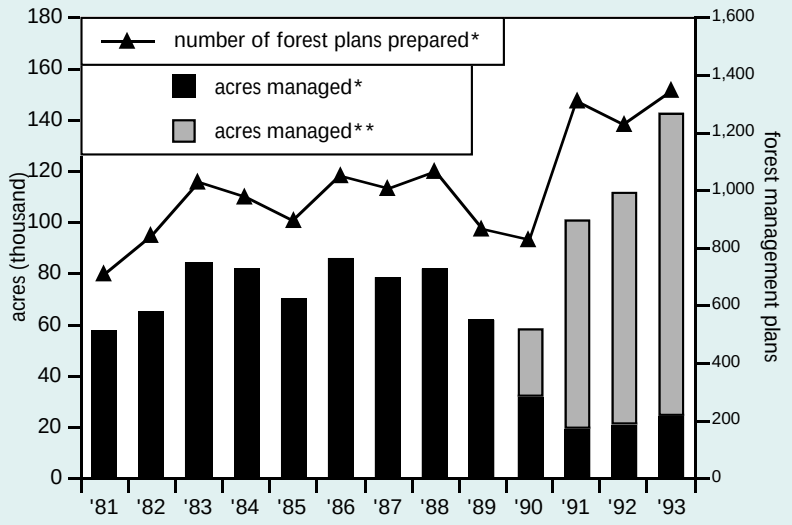
**Volume based on annual four-year averages. 1936-61 averages are based are actual harvest volumes, 1976-93 averages represent volume sold under contract which may not necessarily be harvested that year. Data not available for 1967-71. **Volume reduction in 1993 and 1994 due to numerous administrative appeals of timber sale decisions.*

Source: Kentucky Division of Forestry, U.S. Forest Service, 1994

The annual amount of timber harvested on private lands in Kentucky cannot presently be determined since data is only collected every 10 years through the U.S. Forest Service Surveys. However, logging is likely increasing, as more forest industries locate in the state, demand for wood products rises, and timber stumpage prices increase. Some estimate that about 140,000 acres of forestland are logged each year in Kentucky. The reduction of timber harvests from national and other public forests will place additional demands on private forestlands. Trends reveal that timber harvests have decreased in state owned forests. Average yearly volume of timber harvested from the Daniel Boone National Forest has steadily increased until 1993 when sales fell due to administrative challenges from a public interest group opposed to logging on the national forest. Five to ten percent of Kentucky's timber production presently comes from public lands, according to forest industry estimates.

Figure 15

Management Plans and Acres Managed on Privately Owned Forestland in Kentucky



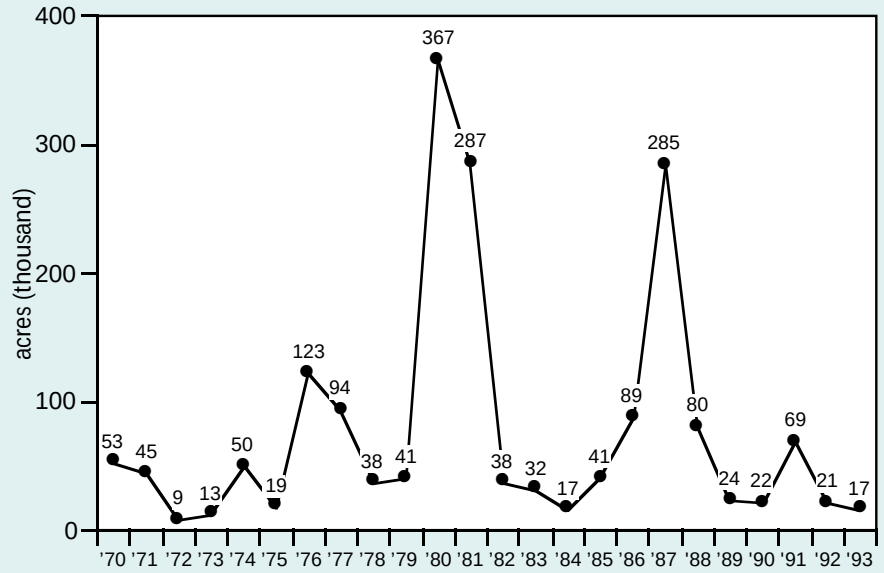
**Acres managed under forest management plans. **Acres managed under Federal forest stewardship and cost-share program established in 1990.*

Source: Kentucky Division of Forestry, 1994

Federal and state government programs to assist private landowners manage their forests have been ongoing for a number of years. Since 1981, the Kentucky Division of Forestry has prepared management plans for more than one million acres of privately owned forestland. But these plans represent less than 10% of 440,000 landowners in Kentucky. A state cost-share fund, established in 1994 to help control water pollution from agriculture and logging operations, although limited, should assist in promoting sound forest stewardship practices.

Figure 16

Forest Fire Trends in Kentucky*



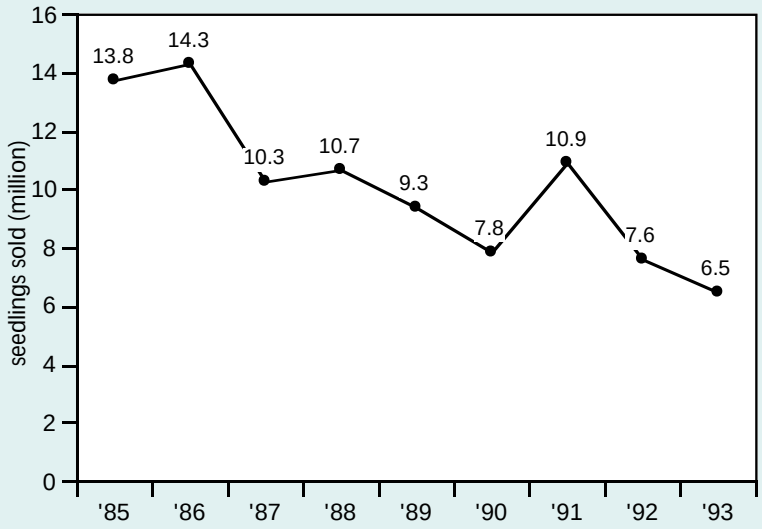
**Excludes fires on Daniel Boone National Forest and other federal lands in Kentucky.*

Source: Kentucky Division of Forestry, 1994

Forest fires are one of the greatest threats to Kentucky's forests. Fifty percent of the 1,025 forest fires in 1993 were purposely set and 31% were caused by carelessness while burning rubbish or clearing farm or other lands. State efforts to prosecute forest fire arsonists continue, with 16 cases pursued in 1993.

Figure 17

Tree Planting Trends in Kentucky



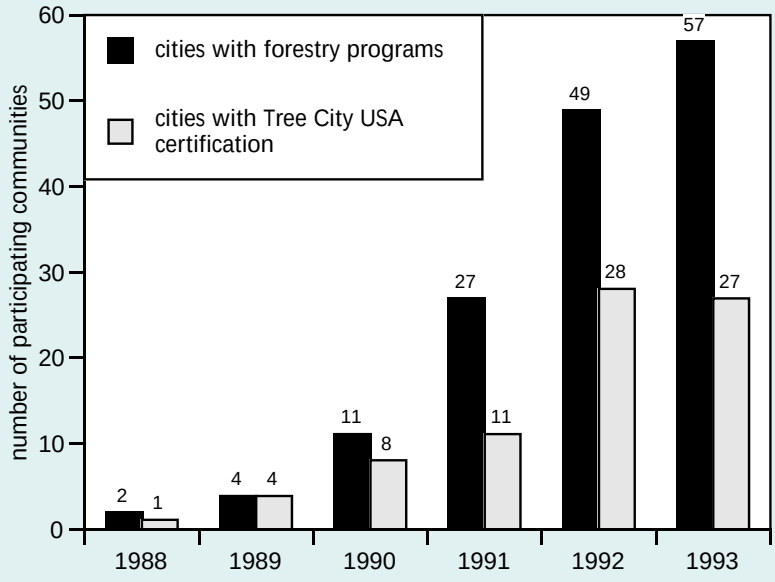
Note: Based on seedlings sold from two Kentucky Division of Forestry nurseries by fiscal year.

Source: Kentucky Division of Forestry, 1994

The number of tree seedlings sold from two nurseries operated by the Division of Forestry continues to decline. This is primarily due to the decreasing number of surface mines in the state which has reduced demand for tree seedlings used for coal mine reclamation. The division reports that demand for seedlings from individuals has remained fairly constant during the past several years.

Figure 18

Urban/Community Forestry Programs in Kentucky



Source: Kentucky Division of Forestry, 1994

As Kentucky's population shifts from rural to more urban, the importance placed on preserving community greenspace and forests has grown significantly. This trend is reflected in the increasing number of cities with urban forestry programs. Urban forests not only beautify communities, they help cleanse the air and provide recreational and educational opportunities.

III. Wildlife Indicators

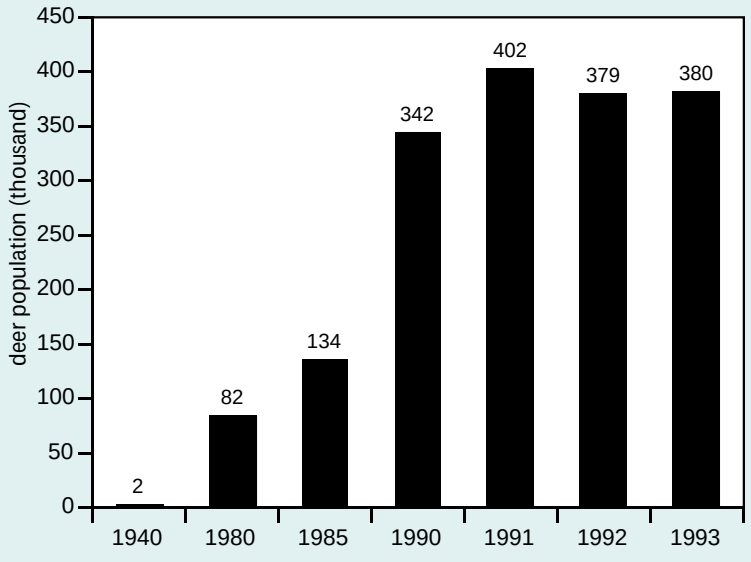
Figure 19
Wildlife Diversity in Kentucky

	Vascular Plants	Fishes*	Amphibians/ Mussels	Reptiles	Birds	Mammals
Number of Species in the United States	25,000	950	297	454	1,683	800
Number of Species in Kentucky	3,000	230	103	105	350	75
% of U.S. Species in Kentucky	12%	24%	35%	23%	21%	9%

*Note: Data is for native species. *Freshwater fishes.*
Source: Kentucky State Nature Preserves Commission, 1994

Kentucky is considered one of the most biologically diverse states in the nation. The Commonwealth harbors a wealth of habitats and is home to a great number of plant and animal species. For example, more than 20% of the freshwater fish, mussel, and bird species in the United States are found in Kentucky.

Figure 20
Deer Population Trends in Kentucky

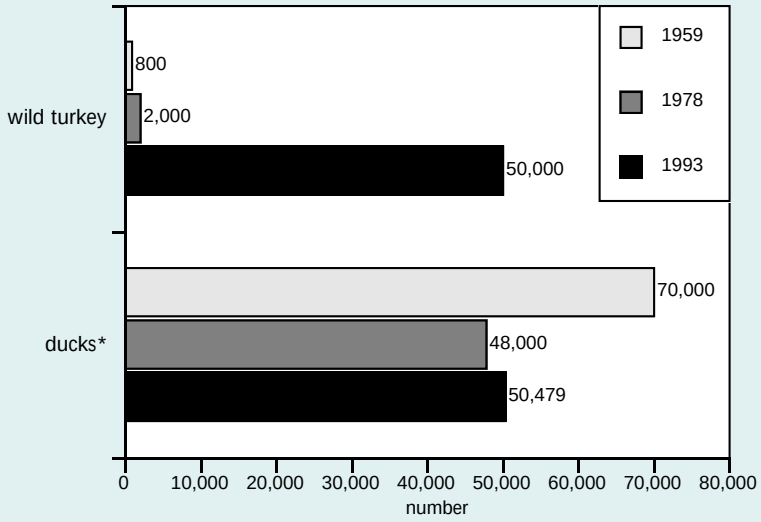


Source: Kentucky Department of Fish and Wildlife Resources, 1994

Deer herds in Kentucky are reported to be stabilizing. Restocking efforts in the 1950's and 1960's have assisted in restoring deer herds to sustainable levels. Unregulated hunting once reduced the number of deer to 2,000. Illegal poaching and free-roaming dogs, however, are affecting deer populations in some areas of the state.

Figure 21

Wild Turkey and Duck Population Trends in Kentucky



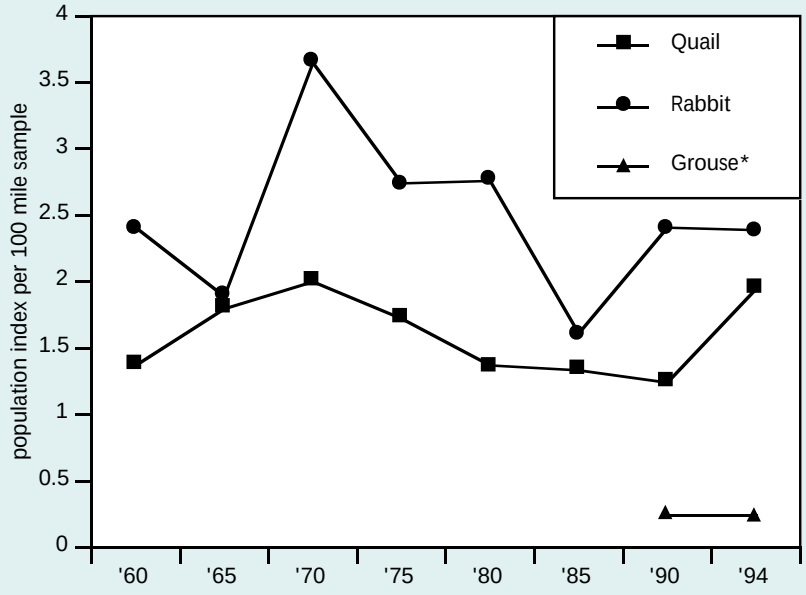
*Based on midwinter waterfowl surveys.

Source: Kentucky Department of Fish and Wildlife Resources, 1994

Kentuckians have committed considerable resources to maintaining and restoring populations of game species of birds and other animals. During the past 17 years, the Division of Fish and Wildlife Resources released 5,847 wild turkeys in 374 areas. This helped to increase populations to their highest number in recent times. However, wild turkey populations are still well below sustainable levels and continued releases will be necessary. The loss of wetlands, which serve as waterfowl breeding grounds, has been directly linked to the decline of duck populations.

Figure 22

Quail, Rabbit, and Grouse Population Trends in Kentucky



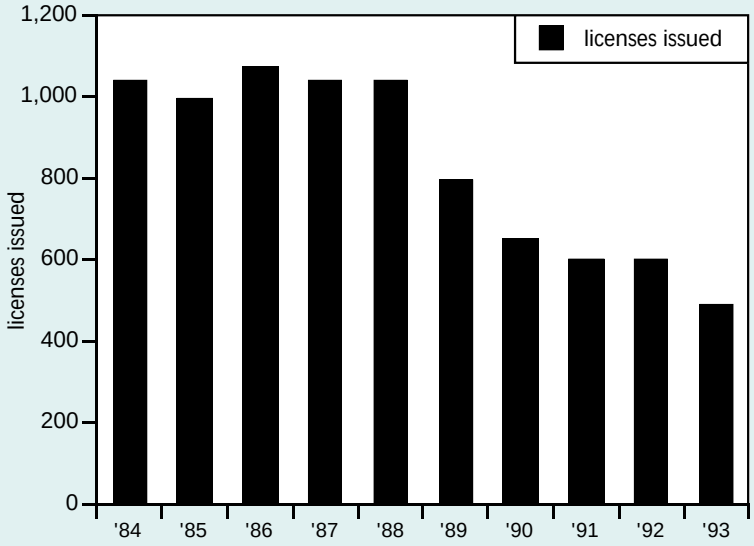
*Based on field surveys conducted at 315 grouse drumming route listening post stops.

Source: Kentucky Department of Fish and Wildlife Resources, 1994

Cottontail rabbit and Bobwhite quail populations have declined primarily in response to harsh winter weather. The Department of Fish and Wildlife Resources renewed its restoration program in 1984 for ruffed grouse after habitat loss in the late 1800's and 1900's nearly eliminated the bird from the state.

Figure 23

Commercial Fishing Licenses in Kentucky

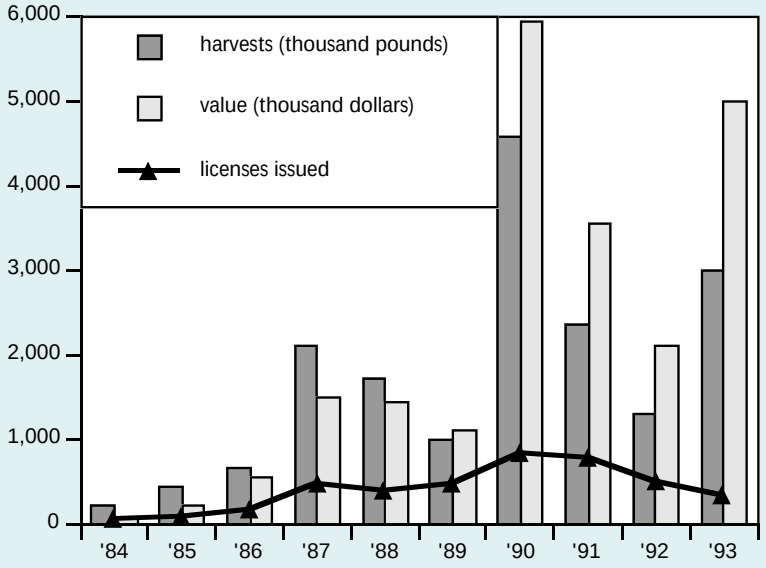


Note: Data on annual commercial fish harvests not collected by the state.
Source: Kentucky Department for Fish and Wildlife Resources, 1994

The state's commercial fishing industry is centered around Kentucky Lake, Lake Barkley, and the lower Ohio River. Of the 489 commercial fisherman licensed, 150 are considered full-time. Catfish is the primary commercial fish species, but harvests also include buffalo fish, carp, and paddlefish. The "wild fish" markets in Kentucky may eventually be taken over by cultured fish raised in aquaculture operations. There are 40 to 50 aquaculture operations in the state, ranging in size from small catfish farms to a large trout operation. Most of the operations sell their fish to the 120 commercial private pay lakes in the state.

Figure 24

Commercial Mussel Harvesting Trends in Kentucky

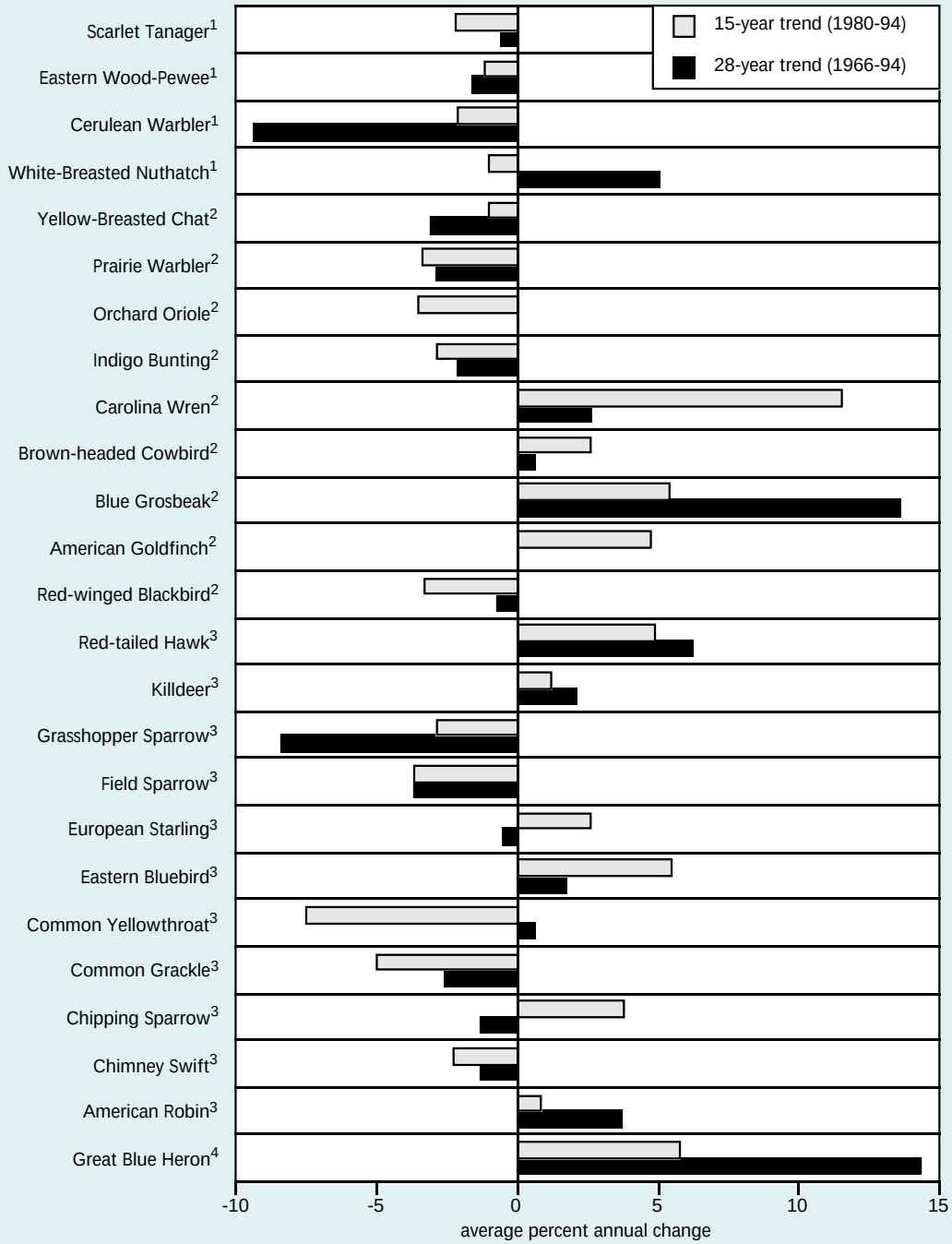


Note: Mussel harvest data does not include illegal harvests which is considered to be significant .
Source: Kentucky Department of Fish and Wildlife Resources, 1994

The commercial harvest of mussels from state waterways has developed into a multimillion dollar industry. The industry expanded rapidly in the 1980's and early 1990's. The Department of Fish and Wildlife Resources established a Mussel Advisory Group in 1991 to develop recommendations regarding commercial musseling in lakes. A number of changes have been implemented as a result of the group's findings.

Figure 25

Bird Population Trends in Kentucky (Selected Species)*



**Species with statistically significant long-term or short-term trends. [1]Woodland habitat. [2]Brushy/mixed habitat. [3]Farm/open land habitat. [4]Water/marsh habitat.*

Source: U.S. Fish and Wildlife Service Breeding Bird Surveys, National Biological Survey, 1994

Songbirds, raptors, and other bird species contribute to the state's uniqueness and ecological health. Changes in bird populations vary due to a number of factors which include cyclic population patterns, weather, introduction of nonnative or exotic species, and destruction of habitat. For example, the Carolina Wren and the Eastern Bluebird populations increased during the last 10 years after suffering heavy losses during the severe winters of the late 1970's. The decline of the Cerulen Warbler is attributed to the loss of mature bottomland forests. Great Blue Heron populations are increasing due to the banning of several chlorinated pesticides and adaptation to new habitats.

Figure 26

Status of Kentucky's Rare Plants and Animals

	Vascular Plants	Fishes	Mussels	Amphibians & Reptiles	Birds	Mammals
Number of Federally Threatened & Endangered Species in U.S.	471	101	56	46	90	65
Number Federally Threatened or Endangered in KY	8	2	11	0	4	3
Number Proposed Federally Threatened and Endangered in U.S.	2,125	133	61	109	59	209
Number of KY Candidates For Federally Threatened or Endangered Listing	26	12	13	5	4	6
Number of KY Species Presumed Extinct or Extirpated	5	9	19	1	7	5
Number of Nonlisted Species of Concern in KY	295	64	35	28	45	16
% of KY Species Considered Rare*	10%	28%	34%	27%	13%	21%

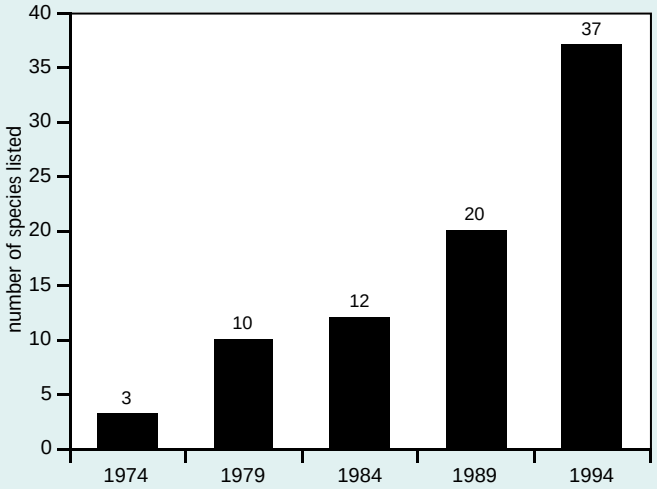
*Note: Other species listed as federally threatened and endangered under the federal Endangered Species Act of 1973 include insects (28), Arachnids (4), snails (21), and crustaceans (13). *Species considered rare in Kentucky but not all necessarily rare in other states.*

Source: Kentucky State Nature Preserves Commission; Kentucky Department of Fish and Wildlife Resources, 1994

The accelerated loss of species diversity is considered one of the greatest ecological threats facing the world today. To date, 1,427 species have been designated endangered or threatened worldwide, 895 of which occur in the United States. In Kentucky, 28% of the fish, 34% of the mussel, 21% of the mammal, 13% of the bird, and 10% of the plant species native to the state are considered rare.

Figure 27

Federally Listed Endangered and Threatened Species Trends in Kentucky

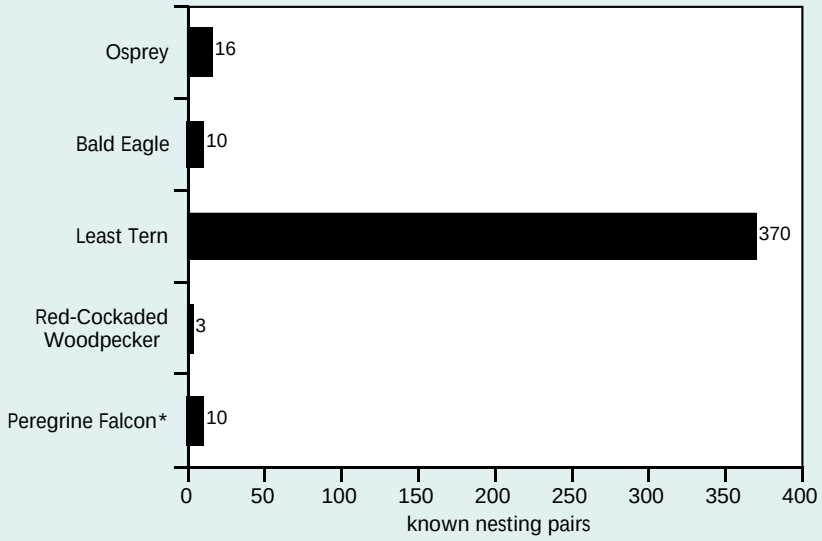


Note: Yearly cumulative total. Excludes 13 species that are federally listed under the federal Endangered Species Act of 1973 but are extirpated from Kentucky and 3 species reported from Kentucky that do not breed here or are only accidental records. The Peregrine Falcon, which has been extirpated from Kentucky, is included due to reintroduction programs.
Source: Kentucky Nature Preserves Commission, 1994

The number of federally listed threatened and endangered species occurring in Kentucky continues to increase as more is learned about various animals and plants, and additional species are listed. Some of these species include the Bald Eagle, Peregrine Falcon, Virginia Big-Eared Bat, and White-Haired Goldenrod.

Figure 28

Known Populations of Selected Rare Bird Species in Kentucky

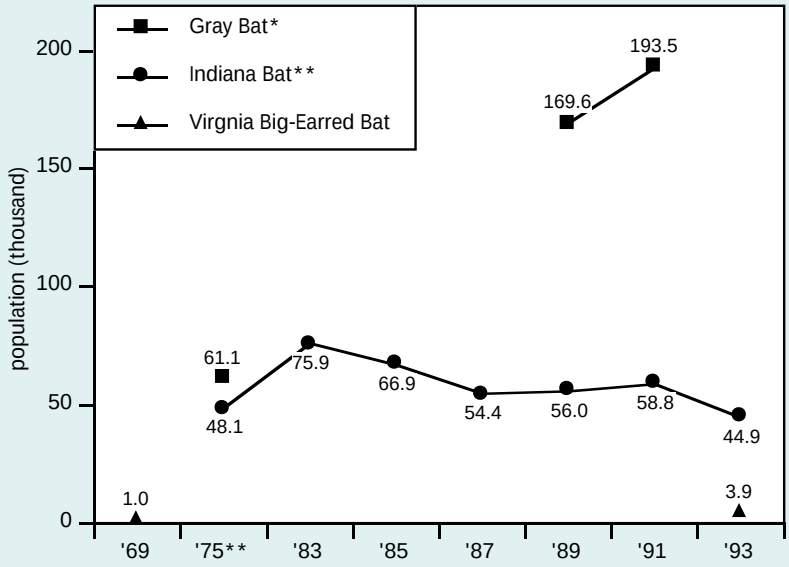


**Based on birds released. No known nesting pairs to date.*
Source: Kentucky Department of Fish and Wildlife Resource, 1994

The Bald Eagle, federally listed as endangered in 1967, has made a dramatic recovery and its status in Kentucky is encouraging. In 1994, ten active eagle nests were observed. The Peregrine Falcon, listed in 1977, has been on the increase in recent years due to the discontinued use of the pesticide DDT and a state restoration project. The Department of Fish and Wildlife Resources hopes to establish at least one nesting pair of falcons in the state by the year 2000. The Red-Cockaded Woodpecker, however, is on the brink of extinction in Kentucky. The U.S. Forest Service is considering setting aside 20,000 acres of pine forests in the Daniel Boone National Forest in an attempt to halt the woodpecker's decline.

Figure 29

Known Populations of Selected Endangered Bat Populations in Kentucky



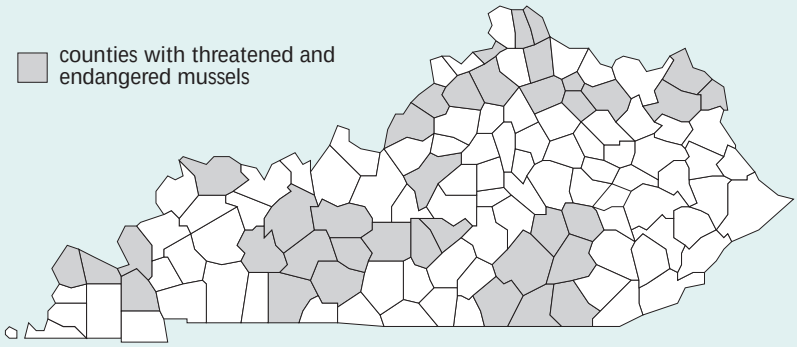
*Note: Some bat data may represent new knowledge of bat populations. *Gray Bat population data appearing for 1975 in chart based on 1979 data **Based on population trends at 3 caves — Bat, Hundred Dome, and Dixon.*

Source: U.S. Fish and Wildlife Service, Kentucky Department of Fish and Wildlife Resources, 1994

Gray Bats were once abundant in the state. Human disturbance and vandalism of caves, however, caused the bat to decline to such low levels that it was listed as endangered in 1976. State and federal measures to protect bat habitat by protecting and fencing some caves have assisted in stabilizing Gray Bat populations. The Indiana Bat, listed as endangered in 1967, continues to decline despite efforts to protect cave habitats. Populations of the endangered Virginia Big-Eared Bat, listed in 1976, have increased after the U.S. Forest Service acquired its only known cave habitat in 1988 and gated it in 1993.

Figure 30

Federally Endangered and Threatened Mussels in Kentucky

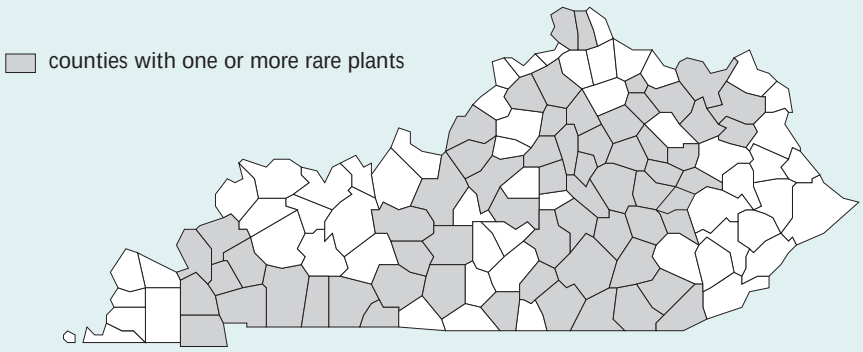


Note: As listed under the federal Endangered Species Act of 1973

Source: Kentucky Nature Preserves Commission, 1994

Kentucky's freshwater mussels were once among the most diverse in the world. However, the loss of native mussels has been significant with 19 of the 103 species native to Kentucky extinct or extirpated from the state. Of the remaining 84 species, 35 are rare. Habitat destruction due to the damming of waterways, mining, and other development activities has greatly impacted populations. And a new threat, the exotic Zebra Mussel, may impact the state's native mussel fauna by encrusting native species.

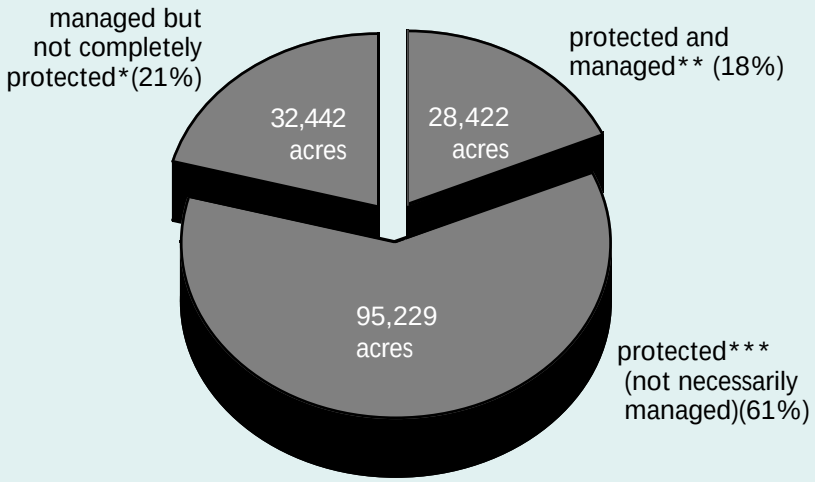
Figure 31
Plants of Federal Concern in Kentucky*



*Plants of federal concern include those listed as threatened, endangered, or proposed for listing, or candidates for listing (categories C1, C2) under the federal Endangered Species Act.
Source: Kentucky Nature Preserves Commission, 1994

There are 329 species of plants considered rare in Kentucky of which 26 are listed as federally threatened or endangered. Each of these species is important to the state's ecological diversity. The Kentucky Legislature passed a bill in 1994 to more fully assess the status of rare plants in the state. The measure calls for an inventory and list of rare plants.

Figure 32
Status of Natural Areas in Kentucky (1994)

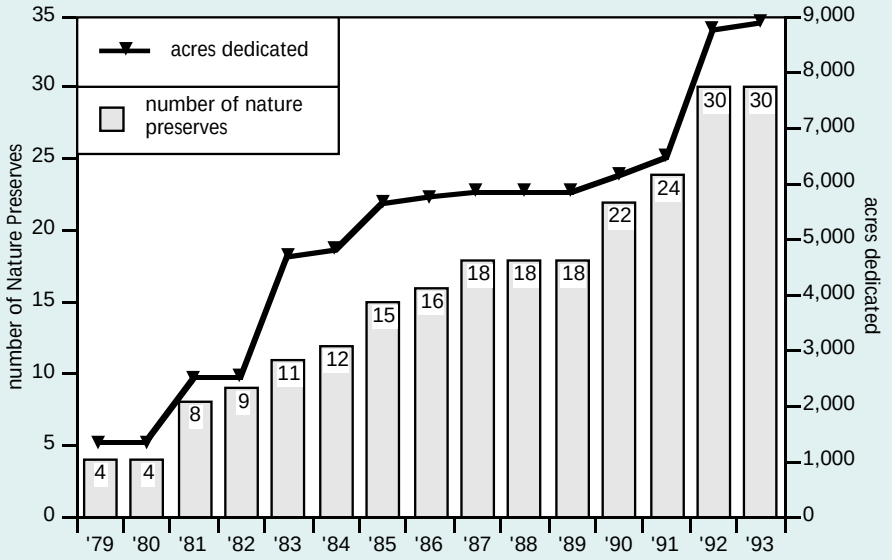


*Managed areas not completely protected - areas protected by an administrative decision or because they are owned by a conservation organization. They include Nature Conservancy Preserves, proposed federal research natural areas, federal special interest areas, federal ecological areas, state registered natural areas owned by federal agencies, state university natural areas, local government natural areas, and certain lands under conservation easement. **Protected and managed natural areas - areas protected by state or federal statute and include state nature preserves, federal wilderness areas, and federal research natural areas. ***Protected but not necessarily managed areas - areas protected from disposal under federal statute but may not be managed solely as natural areas. They include national parks and national wildlife refuges.
Source: Kentucky State Nature Preserves Commission, 1994

The preservation of important habitats is critical to the survival of many rare species and to sustaining the state's biological diversity. To date, 156,093 acres of land has been set aside for wildlife habitat in Kentucky. However, only 28,422 acres are truly protected and managed for rare species.

Figure 33

State Nature Preserves in Kentucky



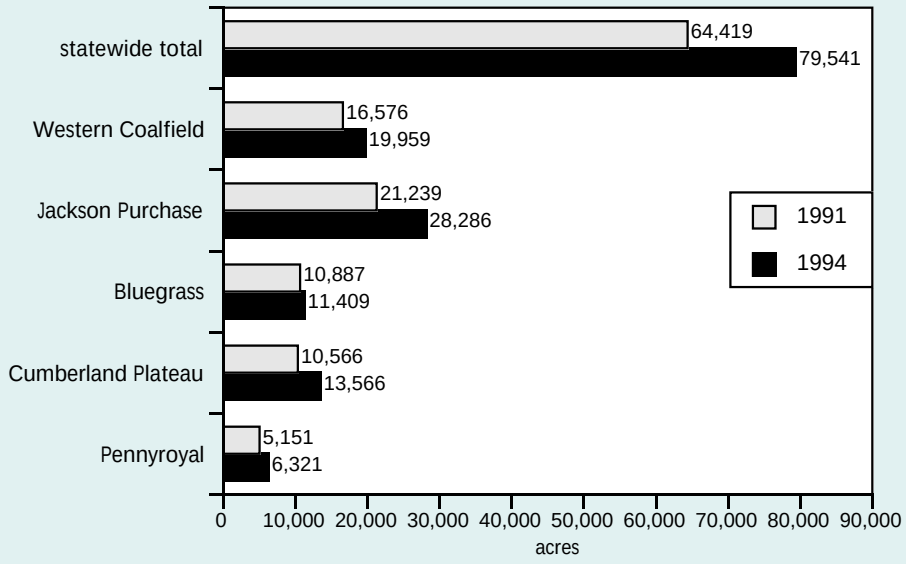
Note: Cumulative yearly totals.

Source: Kentucky Nature Preserves Commission, 1994

To date, 30 State Nature Preserves in 24 counties have been dedicated to protecting unique natural areas and the habitat of rare species. The 1994 designation of a 19.4 mile section of the Red River as Kentucky's first national Wild and Scenic River by the U.S. Congress will also ensure this pristine waterway is preserved for future generations.

Figure 34

Wildlife Management Areas in Kentucky—Statewide and Regional Acreage

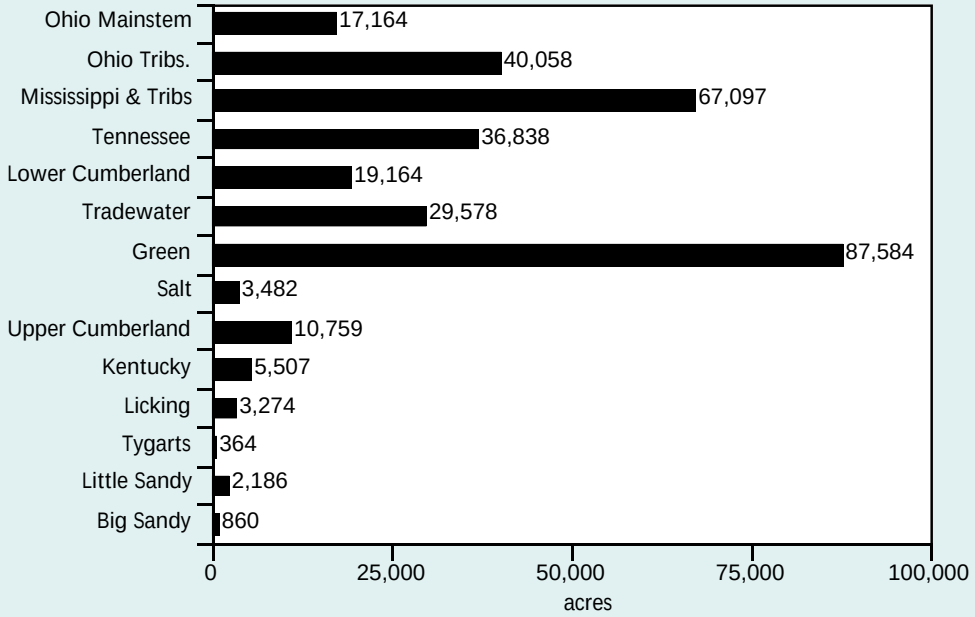


Source: Kentucky Department of Fish and Wildlife Resources, 1994

The Department of Fish and Wildlife Resources purchases land for wildlife management and hunting activities. There are presently 74 wildlife management areas located in 64 counties. The department also currently manages 120,740 acres of private land for wildlife habitat.

Figure 35

Wetland Acreage by River Basin in Kentucky*

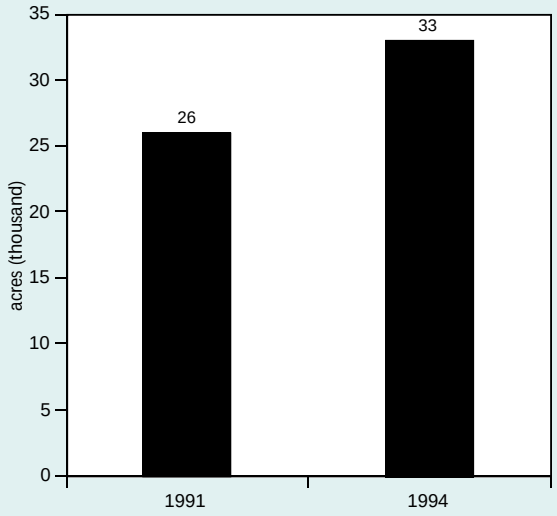


**Includes only palustrine wetlands (freshwater wetlands in a concave or depressional landform dominated by hydrophytic trees, shrubs, and herbaceous plants). Often referred to as bottomland hardwood, floodplain, marsh, oxbow, scrub-shrub, swamp, and wet meadow. Total acreage 323,918 based on state wetland inventory. Wetland defined by the Cowardin Classification System.*
Source: Kentucky Division of Water, Report to Congress on Water Quality, 1994

Wetlands are considered among the most biologically diverse ecosystems. Kentucky's wetlands provide habitat to 24 of the state's 37 federally listed endangered and threatened species. At one time, wetlands covered an estimated 1.6 million acres of land in Kentucky. A recent state wetland inventory revealed that wetland acreage has declined to 323,918 acres as a result of development and conversion to other uses. The decline of wetlands during the past several years has slowed since federal and state regulations and disincentives for altering wetlands have been established.

Figure 36

Wetland Acreage Purchased for Waterfowl Habitat in Kentucky

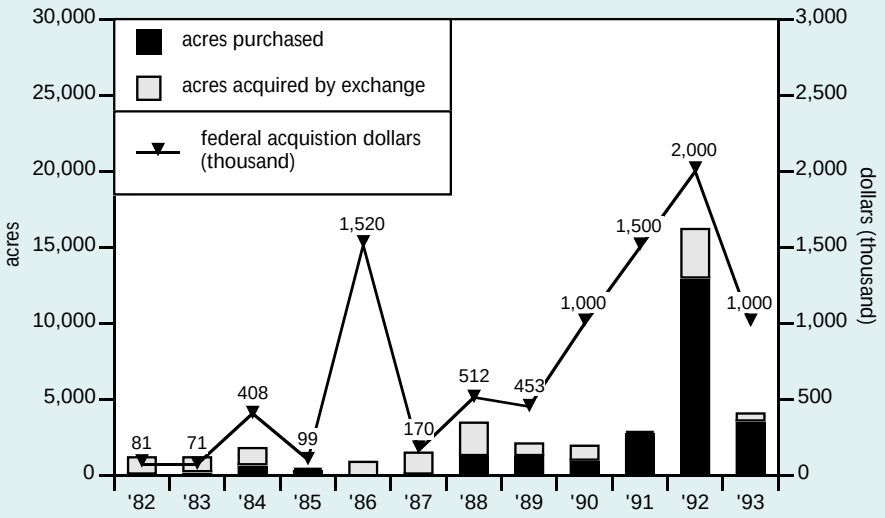


Note: Includes those wetlands purchased by the Kentucky Department for Fish and Wildlife Resources.
Source: Kentucky Department of Fish and Wildlife Resources, 1994

The Kentucky Department of Fish and Wildlife Resources has increased its efforts to purchase wetlands in order to protect this important habitat. The establishment of a National Wildlife Refuge in the state is also a high priority of the department.

Figure 37

Land Acquisition Trends for the Daniel Boone National Forest

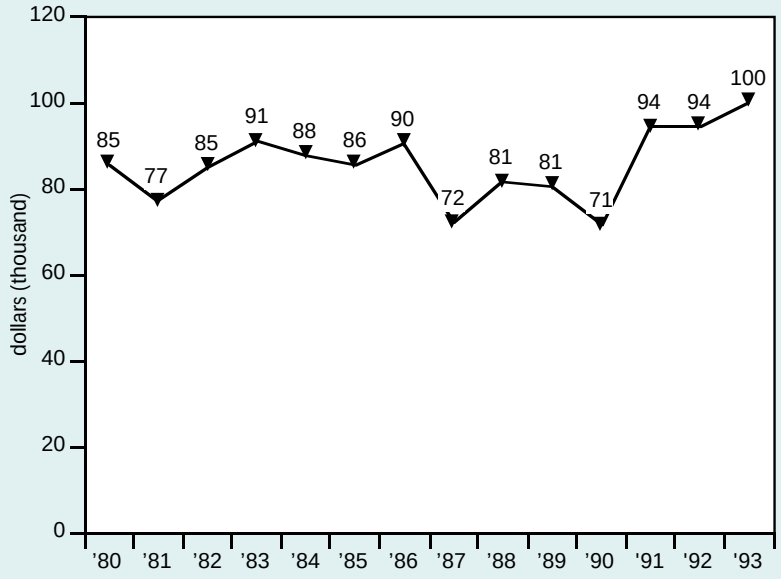


Source: U.S. Forest Service, Daniel Boone National Forest, 1994

The state's only national forest—the Daniel Boone—was established in 1937 from a patchwork of private land in Eastern Kentucky. The forest now covers 700,000 acres in 20 counties. Federal appropriations to purchase national forestland in Kentucky have increased since 1989 primarily in response to public interest and support. Much of the land recently purchased provides for rare species habitat.

Figure 38

Revenue Generated From Nature and Wildlife Fund State Income Tax Checkoff in Kentucky



Source: Kentucky Nature Preserves Commission, 1994

Kentucky has relied on the State Income Tax Checkoff Program to fund the purchase of natural areas. Since 1980, taxpayers have contributed $1.2 million to preserve important habitats through the checkoff program. A new fund—the Heritage Land Conservation Fund—created in 1994, will, for the first time, provide a dedicated source of state funds to acquire critical habitats from willing sellers. The state is also raising money to purchase 2,350 acres of Blanton Forest. The forest was recently "discovered" in Harlan County and is one of the largest remaining tracts of old-growth forest in the Eastern United States.

Chapter 6

Resource Extraction

Resource Extraction

Kentucky has vast reserves of coal, oil, and natural gas which contribute to our economy and the nation's energy needs. However, the extraction of these resources can impact the environment. State and federal laws to regulate coal mining and oil and natural gas drilling have led to environmental improvements. Indicators in this chapter are intended to continually monitor the state's progress in balancing the production of its coal, oil, and natural gas resources with environmental integrity.

I. Coal Mining, Reclamation, and Abandoned Mine Land Indicators

Kentucky's and the nation's coal industry have undergone significant changes in the past 20 years. National coal production has increased 50% since the enactment of the federal Surface Mining Reclamation and Control Act of 1977, the primary law governing the removal of coal and the reclamation of mine sites. Coal is now a primary source of energy in the United States and production levels are expected to continue to increase in the future.

Production. Coal production has remained fairly constant since 1984 in both the eastern and western regions of the state. Eastern Kentucky coal fields accounted for 76% of the 168.2 million tons of coal mined during 1993. According to the Kentucky Coal Marketing and Export Council, 7.7 billion tons of coal have been mined in the state over the past 200 years. They estimate about 38 billion tons of recoverable coal remain.

The mining of coal has changed as technologies and federal and state laws and regulations governing its removal have been enacted. Surface mining has been widely used in Kentucky to recover coal. But during the past ten years the use of underground mining methods have increased. Sixty percent of the 168.2 million tons of coal produced in the state during 1993 was recovered using underground mining methods. Underground mining has grown as coal seams closer to the surface are depleted, technology improves, and companies seek to minimize reclamation and other regulatory costs associated with surface mining.

While the number of mines is declining, the amount of coal produced has remained fairly constant during this time period. The number of mines in Kentucky fell, from 2,063 in 1984 to 696 in 1993. This reflects the mining industry's consolidation of its operations into larger more

Highlights

Coal Mining

- Coal production declined slightly in the state during 1993. Of the 168.2 million tons of coal extracted, 76% was mined in Eastern Kentucky, primarily using underground mining methods. The state currently ranks second in the nation in coal production.
- Fewer mines are producing greater quantities of coal as the industry consolidates its holdings into larger more mechanized mining complexes.
- Coal industry compliance with environmental requirements has steadily improved. Violations involving sediment control and backfilling and grading were the most frequently cited of the 2,662 violations recorded during 1993.
- Coal mine forfeitures continue to decline in the state as industry compliance improves and 2-acre and older mine sites are eliminated.
- Since 1982, 18,330 acres of abandoned mine lands have been reclaimed. An estimated 80,000 acres are still potentially eligible for reclamation.

Oil and Natural Gas

- An estimated 35,000 oil and natural gas wells are operating in the state. Crude oil production has remained constant since 1987, however, natural gas production has increased in recent years.
- Stepped up enforcement of water quality regulations and industry efforts to better control brine discharges from oil drilling operations have reduced levels of chloride pollution in several streams.
- A recent screening of oil pits in Lawrence and Johnson counties revealed that 23% of the sites had radium levels above those naturally occurring in the soil. The state is developing standards for the cleanup of contaminated sites.
- The high rate of bond forfeitures for the failure to properly plug an oil or gas well continues as older drilling operations are addressed. During 1993, nearly as many oil and natural gas well bonds were forfeited as released.
- There are an estimated 33,011 abandoned oil and gas wells in Kentucky. To date, 772 of these abandoned wells have been plugged with state funds.

mechanized mine complexes. This is also due to the elimination of 2-acre mine sites, which once numbered more than 2,000 and were exempt from regulatory requirements of the federal surface mining law, although they were regulated under state law. The 2-acre exemption was repealed in 1987 due to mining abuses. The mechanization of mines, while increasing production, has also reduced coal mining employment in the state from 48,050 in 1981 to just over 25,000 in 1993.

Operation and Reclamation. Each year thousands of acres of land are permitted for coal mining in the state. Currently, there are 1,000 underground and 1,177 surface mining permits active in Kentucky. Permitted operations include active coal mining sites and those in the process of reclamation. Multiple permits are often issued for a mining complex. As of December 1993, 263,356 acres of land was disturbed or being reclaimed under those permits with about 74% of this acreage located in Eastern Kentucky.

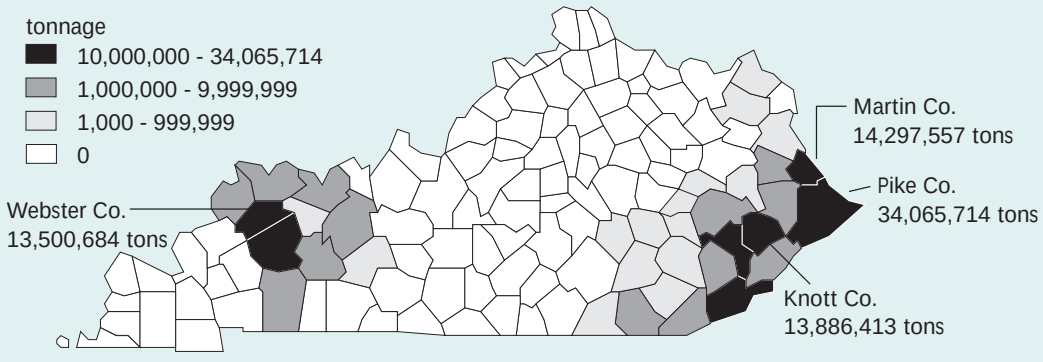
Industry compliance with coal mining regulations has steadily improved over the past several years in the state. Surveys conducted by the federal Office of Surface Mining in fiscal year 1993-94 reveal that 73% of coal mines were in compliance with environmental regulations. During that time state officials issued the lowest number of mine violations recorded to date. Sediment control and backfill and grading led in the number of violations cited—about 20% of the 2,662 violations issued in 1993. Water violations, however, are increasingly being cited at coal mines as state officials step up enforcement efforts to address and prevent water pollution problems.

Indicators reveal that the forfeiture of coal mine bonds, which are required to assure adequate funds for the reclamation of a site, has declined in Kentucky. During 1993, the state released coal mine bonds affecting 27,000 acres after the completion of reclamation. That same year coal mine bond forfeitures fell to a low of 1,940 acres compared to a high of 7,960 acres in 1989. The overall reduction in coal mine forfeitures is attributed to better reclamation by operators as well as the elimination of 2-acre and older interim mines.

A majority of coal mines in the state are reclaimed to forest or grassland. Efforts to improve reclamation practices has led one company, the Ark Land Company, a subsidiary of Arch Mineral Corporation, to try new methods of reforestation on coal mines in Eastern Kentucky. Golden Oak Mining and the University of Kentucky Agricultural Extension Service are also experimenting with the use of native prairie grasses and wildflowers to reclaim two- to four-acre plots in Isom, Kentucky. Prairie grasses are more expensive than the fescue and other turf grasses typically used to reclaim mine sites, but provide better habitat and food for quail and other wildlife.

Abandoned Mine Lands. Old abandoned mine lands continue to pose environmental and public safety problems in the state. It is not known exactly how many acres of abandoned mines there are in Kentucky but estimates range in excess of 100,000 acres, of which more than

Coal Production in Kentucky and Top Producing Counties (1993)



Source: Kentucky Geologic Survey, 1994

80,000 acres are potentially eligible for reclamation.

The state is dependent on the federal Abandoned Mine Land (AML) Fund to reclaim old pre-1977 mine sites. The fund is financed by a fee imposed on coal produced in the United States. Monies from the fund are apportioned back to coal producing states for mine land reclamation.

From 1978 through 1994, Kentucky has paid $590 million in fees into the fund and, since 1982, has received $224 million back in grant allocations. To date, the state and federal government have reclaimed 18,330 acres of abandoned mine lands and initiated hundreds of projects to address abandoned mine land problems.

Recently, additional attention has focused on supplying water to households whose wells had been contaminated or disrupted by old mine sites. During the past two years, nine waterline projects have been funded bringing the total number of waterline extension projects approved since 1982 to 28 at a cost of $30 million.

The amount of federal AML Funds apportioned back to Kentucky has steadily declined during the past 11 years. Under federal law, the state is entitled to a 50% return. A total of $70 million in Kentucky share money paid into the fund since 1978 has not been reallocated to the state. This has been a point of contention with state officials especially in light of the present $842 million balance in the national fund.

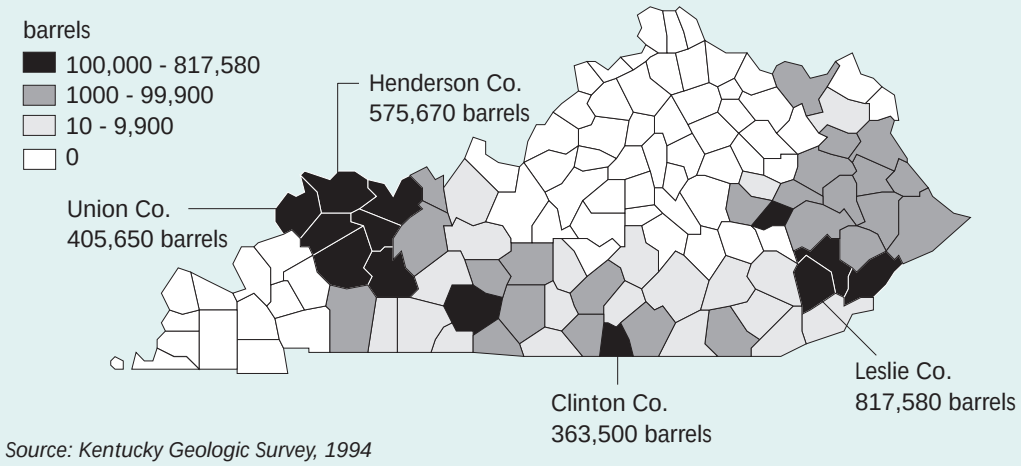
Abandoned mine lands continue to pose problems in the state. Of particular concern are landslides at old mine sites. Since 1982, the state has addressed 2,479 landslides which were considered a threat to public safety and property. Last year, flash flooding and a severe winter led to an increasing number of emergency landslide situations. After considerable pressure by state officials, the federal government appropriated $7.1 million from the national Emergency Relief Act of 1994 to supplement Kentucky's $5 million AML allocation to address abandoned mine land emergencies. From 1978 through 1994, $72.6 million in emergency federal AML Funds have been spent to address problems at old mine sites in the state.

II. Oil and Natural Gas Indicators

The oil and natural gas drilling industry has been subject to increased environmental scrutiny during the past several years. Stronger enforcement and better industry compliance with state and federal regulations that require proper well drilling practices and disposal of oil and gas field wastes has resulted in some environmental improvements in the past few years. But indicators in this chapter continue to reveal environmental threats from thousands of unplugged wells and contamination from naturally occurring radiation at oil sites.

Production. There are an estimated 35,000 active wells producing oil and gas in Kentucky. Crude oil production has remained fairly constant since 1987. Oil well production levels in 1993 ranged from a high of 1,000 barrels a day to less than one barrel a day. Most oil wells in the state, however, produce less than 10 barrels of oil a day. In 1993, more than 23,500 wells in 59 counties produced

Crude Oil Production in Kentucky and Top Producing Counties (1993)



Source: Kentucky Geologic Survey, 1994

4.6 million barrels of oil ranking Kentucky 20th in the nation in crude oil production.

Natural gas production is increasing in Kentucky. This is attributed to several factors including growing demand due to the clean burning characteristics of natural gas, a slight increase in natural gas prices, recently enacted federal tax credits, and the deregulation of natural gas prices by the federal Energy Regulatory Commission allowing smaller independent operators access to natural gas transmission pipelines. During 1993, 12,836 wells in 32 counties produced 87 billion cubic feet of natural gas ranking the state 18th in the nation in the volume of gas produced.

Natural gas production primarily occurs in Eastern Kentucky. However, a 1993 Kentucky Geological Survey report may promote further exploration in natural gas fields in Western Kentucky. The agency found that 12 counties in an area from Union County east to Grayson and Edmonson counties may be the site of a major natural gas field.

Operation and Regulation. Oil and gas wells can cause environmental impacts if not properly drilled, operated, plugged, and reclaimed.

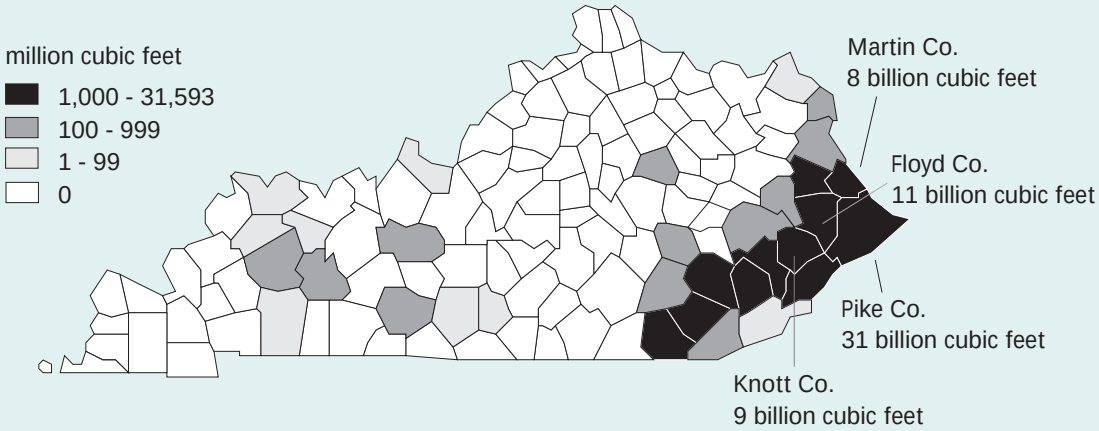
Of particular concern is the salty brine extracted during oil and gas drilling operations. Brine water is toxic to fish and can impair the ability to use waterways for drinking water purposes. The state established chloride standards in 1985 to regulate brine discharges to waterways. State enforcement of this standard along with better industry compliance and a decline in oil production has resulted in water quality improvements at 19 of the 21 streams monitored for chlorides.

Many oil and gas operations dispose of brine by reinjecting it back into the ground. Currently, 2,620 brine injection wells are operating in the state and another 1,313 are considered inactive. The proper operation and plugging of these wells is monitored by the U.S. Environmental Protection Agency. In 1993, 42 enforcement actions were taken against improperly operated wells. A majority of these violations were at wells in operation prior to 1984.

Of more recent concern, however, is the discovery of radioactive contamination at oil fields. High levels of naturally occurring radioactive material (NORM) at some oil pits in the Martha Oil Field has led the state to undertake a more in-depth study of the problem. Radioactive materials are found naturally in underground geologic formations. But water used to force extra oil out of wells in the mid 20th century brought crude oil, water, and radium to the surface. The process of separating the oil from the water and the subsequent disposal of the water left varying amounts of radium in some oil fields.

It is not known how extensive NORM is in Kentucky. Some oil pits tested in the Martha Oil Field detected levels of radioactivity high enough to warrant clean up. A year-long state study, which began in the spring of 1994 revealed that 23% of the sites screened in Lawrence and Johnson counties had radium contamination above levels naturally occurring in the soil. The Department for Health

Natural Gas Production in Kentucky and Top Producing Counties (1993)



Source: Kentucky Geologic Survey, 1994

Services is developing standards for the cleanup of NORM contaminated sites and disposal of these wastes.

Enforcement. The Division of Oil and Gas, within Department of Mines and Minerals, is the state agency in charge of policing the operation and plugging of oil and gas wells. The division recently increased its enforcement efforts to require the plugging of inactive wells to prevent groundwater contamination problems. These actions have resulted in the forfeiture of a number of oil and gas bonds for the failure to properly plug a well. During 1993, 312 well bonds were forfeited while 382 bonds were released for proper reclamation. A majority of the forfeited operations were older sites.

A state law, passed in 1994, will further regulate the oil and gas drilling industry. The law provides surface landowners an opportunity to approve drilling plans and requires the replacement of water and reclamation of property if damaged by operations.

The law also requires drilling operations to place warning signs on oil storage tanks, known as tank batteries, which are used to separate out production wastes from the crude oil. Since 1984, operators have been required to register tanks with the Division of Water. Currently 9,025 tank batteries are registered of which 7,025 are in active use.

It is not known how many abandoned oil tanks exist in Kentucky. Some estimate they number in the thousands. The state does not have a program or funds to identify or cleanup and remove these tanks. A peer-review study of the oil and gas program by the U.S. EPA and the Interstate Oil and Gas Commission, to be released in March 1995, is reviewing this and other issues and will offer recommendations for improving oil and gas regulatory programs in the state.

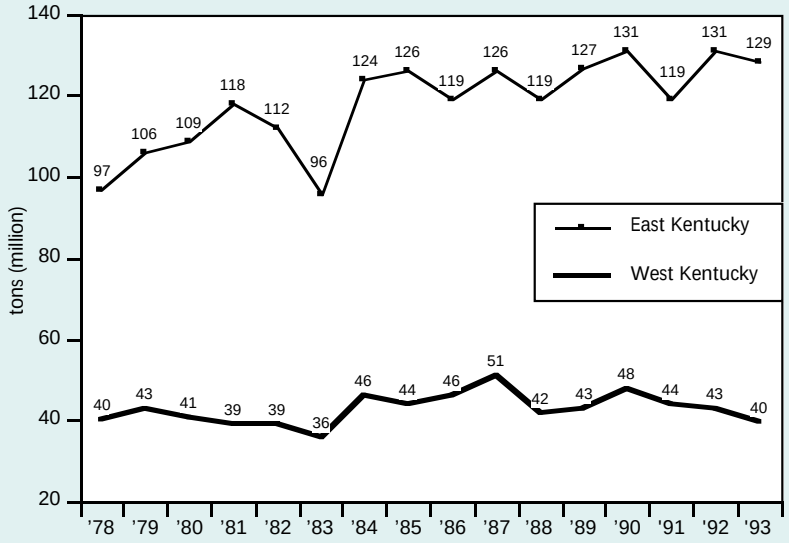
Abandoned Oil and Gas Wells. There are an estimated 33,011 abandoned oil and gas wells in Kentucky, according to state records. This number was revised from 1992 estimates and now includes only those wells drilled since regulation began in 1966 and those pre-regulatory wells where data exists.

Since 1986, 752 abandoned wells have been plugged by the Division of Oil and Gas. The cost to plug a well can range from $900 to $9,000 based on the site but, on average, costs $2,800. The division relies on interest monies generated on posted cash oil and gas bonds and bond forfeitures to plug abandoned wells. Since 1990, $800,000 has been used to plug wells with the greatest potential to cause environmental harm. ■

I. Coal Mining, Reclamation, and Abandoned Mine Land Indicators

Figure 1

Regional Coal Production in Kentucky

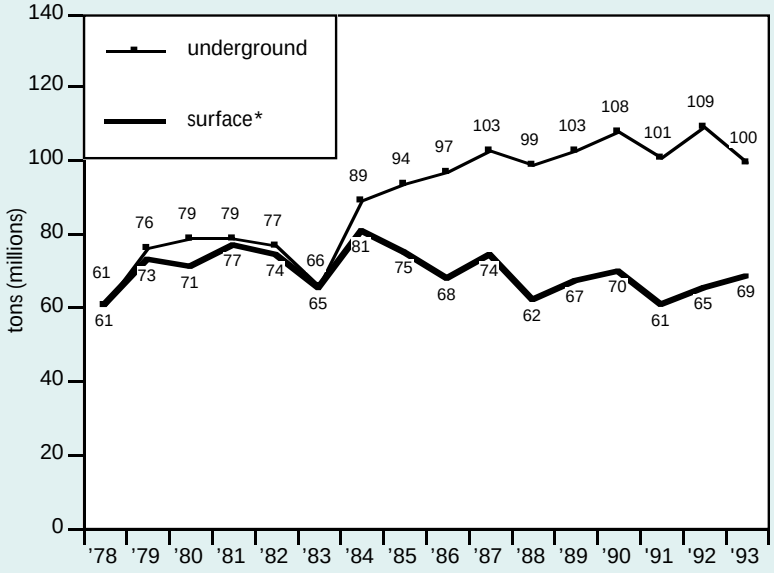


Source: Kentucky Department of Mines and Minerals, Annual Reports, 1978-1994

Industry analysts predict that higher coal prices, cold winters, and depleting power plant stockpiles have led to an increase in national coal production levels. The outlook for Kentucky coal production, however, is for slow growth, perhaps one percent per year. This is attributed to the federal Clean Air Act Amendments of 1990 which has decreased demand for higher sulfur coal, especially in the Western Kentucky coal fields. Despite this, the state still ranked second in the nation for coal production following Wyoming in 1993. Kentucky produced about 17% of the 944 million tons of coal mined in the U.S. during 1993.

Figure 2

Coal Mining Methods in Kentucky



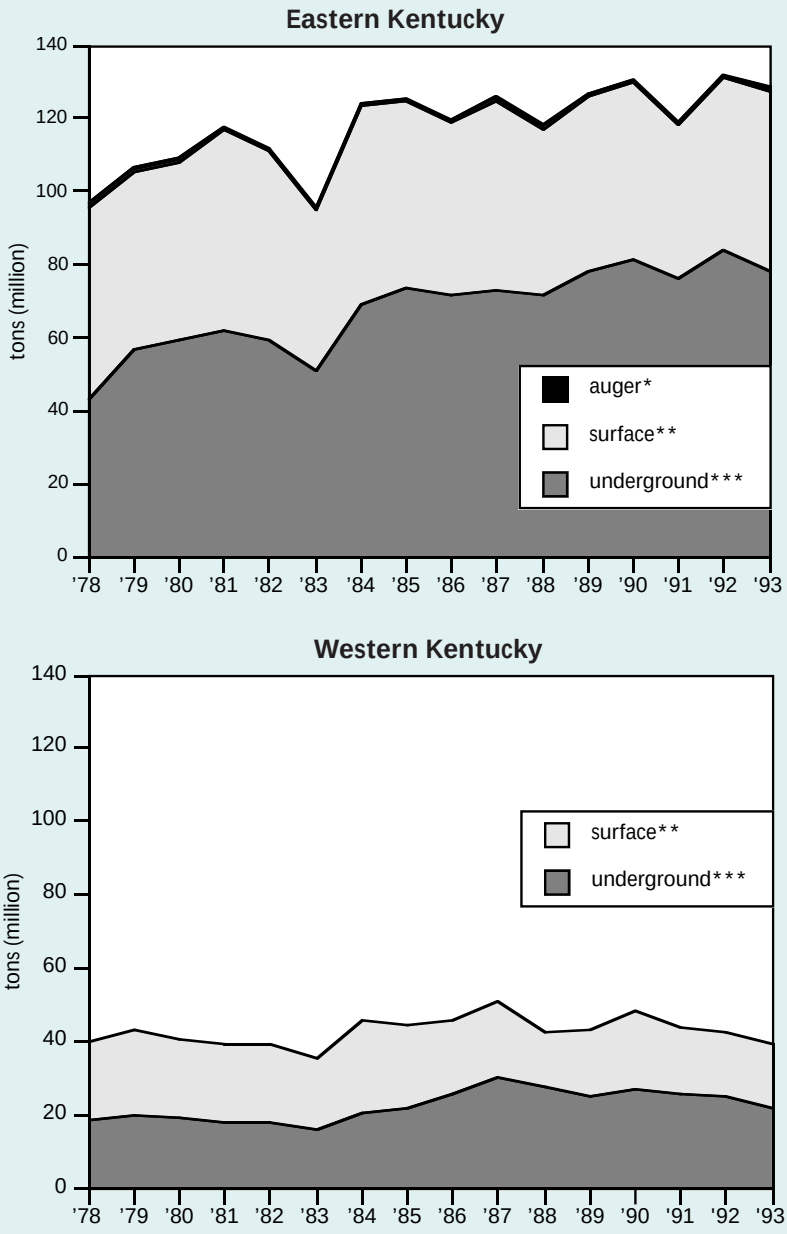
**Includes strip, auger, and auger/strip.*

Source: Kentucky Department of Mines and Minerals, Annual Reports, 1978-1994

About 60% of the coal mined in Kentucky was removed using underground mining technology. Underground mining has become the preferred method of mining as coal seams near the surface have been depleted and companies seek to minimize the reclamation costs associated with surface mines.

Figure 3

Coal Mining Methods by Region in Kentucky

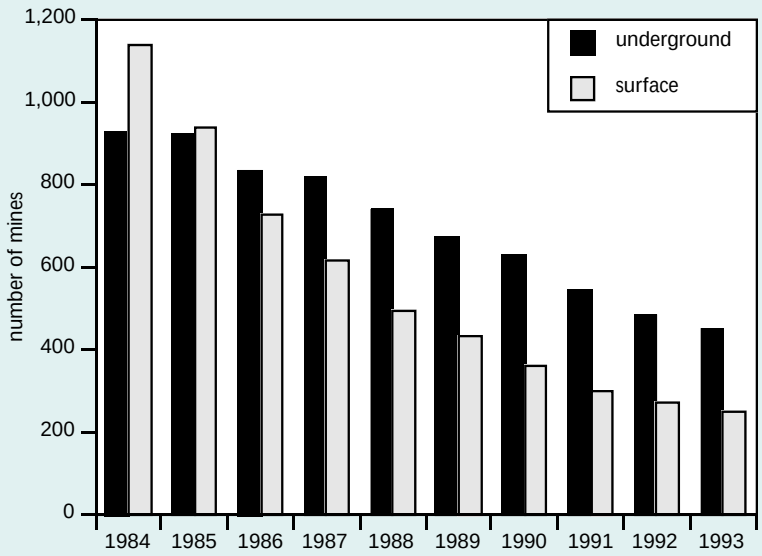


**Auger mining extracts coal from underneath the remaining mountain or hill top. **Surface mining is primarily the use of mountain top and contour mining in the East Kentucky and area mining in the West Kentucky. Also includes auger/surface mining most often used with contour mining. ***Underground mining is primarily the use of room and pillar, long wall, and drift mining techniques.*

Source: Kentucky Department of Mines and Minerals, Annual Reports, 1994

Coal mining methods vary by region. In 1993, underground mining accounted for 61% of the coal extracted in the eastern coal fields and 54% in the west. The remainder was removed using surface mining methods which include mountain top and contour mining in the east and area mining in the west. Each type of mining method is regulated based on its environmental impacts.

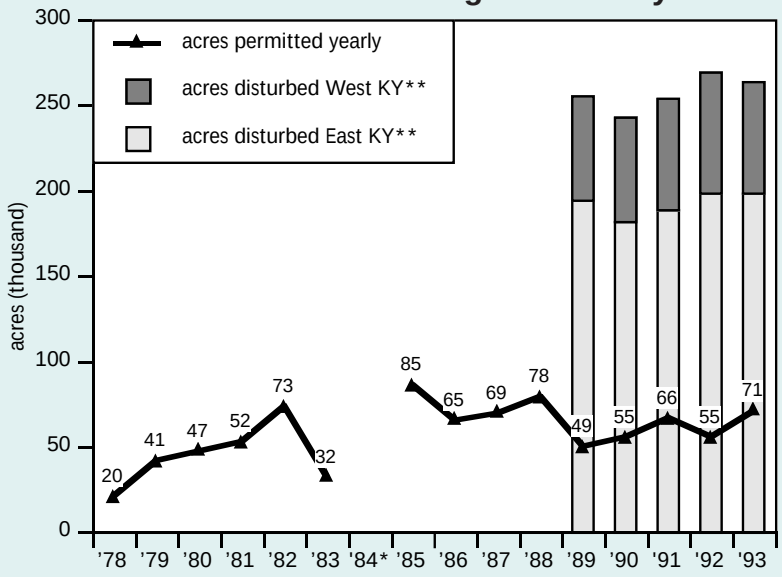
Figure 4
Number of Coal Mines in Kentucky



Source: Provided by the Kentucky Coal Marketing and Export Council based on U.S. Department of Energy, Energy Information Administration, Coal Production, 1984-1992; State Coal Profiles, Coal Industry Annual, 1994

While coal production has remained fairly constant in Kentucky, the number of mines has actually declined. The decline reflects a trend toward the consolidation of activity into fewer but larger mining complexes. The elimination of the 2-acre and older operations has also reduced the number of mines in the state.

Figure 5
Acres Permitted for Coal Mining In Kentucky

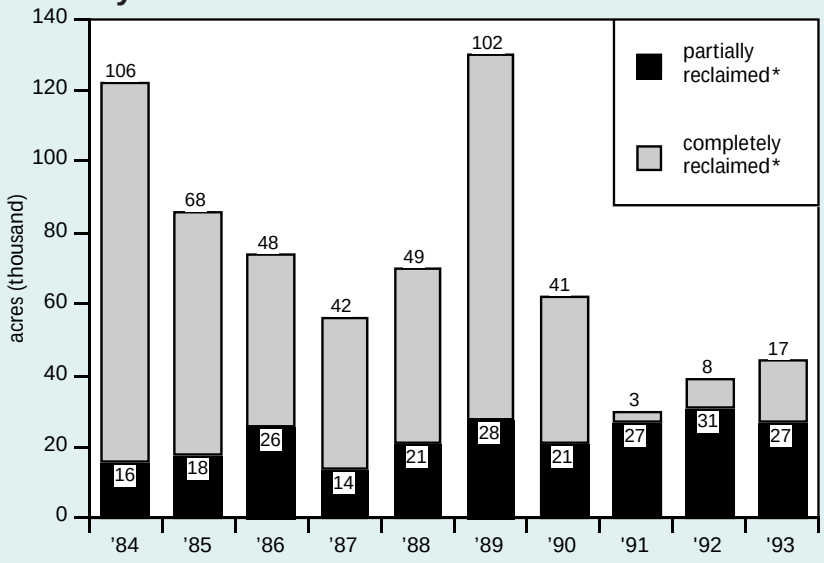


*Note: Permitted acreage does not include acreage added under permit revisions or amendments. *1984 acreage not shown (517,000 acres repermitted as a result of the transition from interim to permanent program which also includes acreage permitted for the first time that overlays underground workings). **Acreage disturbed by permitted mines either actively mining or in some stage of reclamation as of December 30 for each year provided. Earlier data not available.*
Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1994

While the number of coal mines continues to decline, the acres permitted in 1993 for mining increased to its highest level since 1989. The amount of land disturbed or being reclaimed by coal mine operations has remained fairly constant since 1989. About 74% of the 263,356 acres disturbed by mining or in the process of reclamation in 1993 were located in the East Kentucky where a majority of the coal is mined in the state.

Figure 6

Permitted Coal Mine Acres Partially or Fully Reclaimed in Kentucky



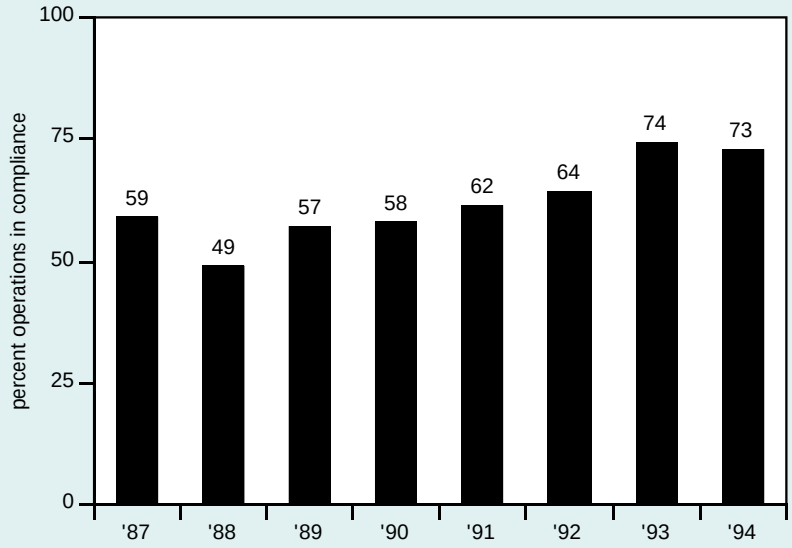
*Based on partial or full coal mine bond releases.

Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1994

Each year thousands of acres of coal mines are reclaimed as required under state and federal law. Most are reclaimed for hay, pastureland, and forestland purposes. Mines are also increasingly being reclaimed for fish and wildlife habitat. State officials recently revised reclamation requirements to further promote forestland as a mine reclamation option.

Figure 7

Compliance of Coal Mining Operations in Kentucky



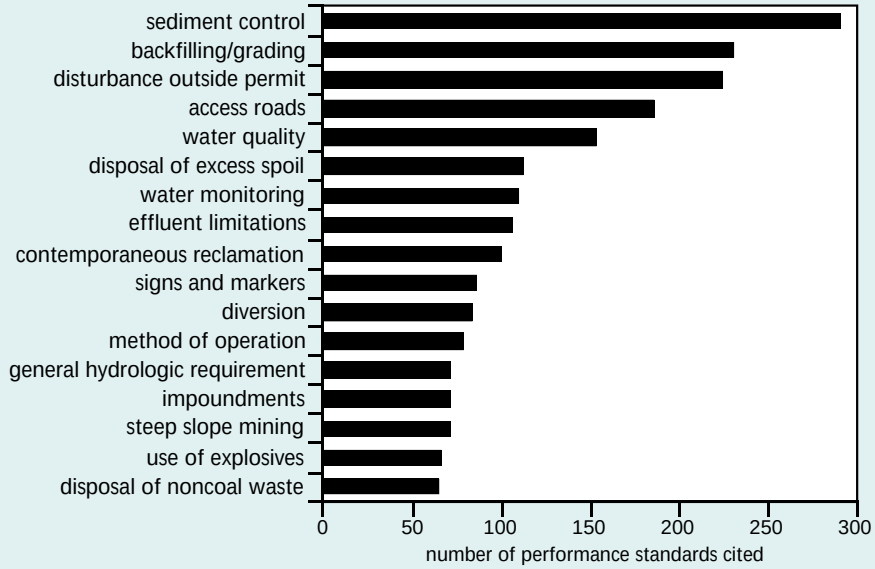
Note: Based on oversight inspections by the federal Office of Surface Mining. The purpose of the inspections is to evaluate the degree of industry compliance and Kentucky's administration of its inspection and enforcement program. By fiscal year.

Source: Annual Reports on Kentucky Permanent Program, U.S. Office of Surface Mining ,1987-94

Compliance by the coal industry with environmental rules has steadily improved in Kentucky. According to the federal Office of Surface Mining, a majority of the violations cited at coal mine operations in the state have a moderate impact to the environment. The agency found the primary cause of violations are often operator neglect.

Figure 8

Most Frequently Cited Coal Mine Violations by Type in Kentucky

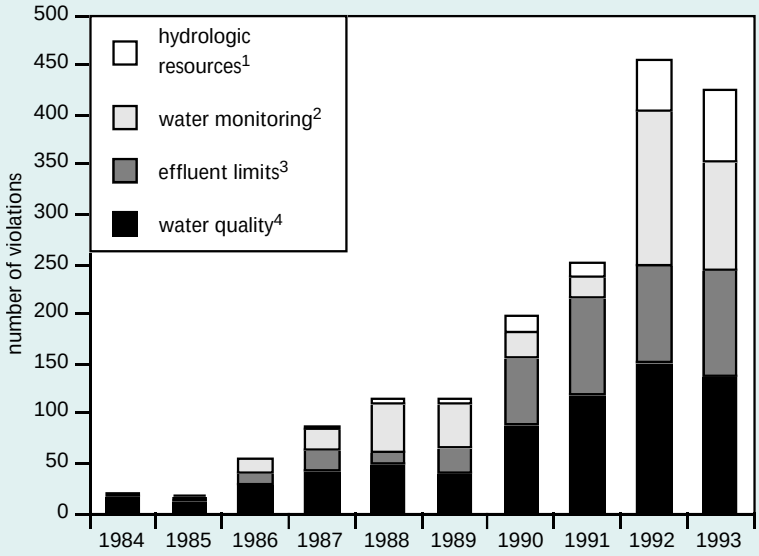


Note: Based on performance standards established to protect the environment. The above violations total 2,097, about 79% of the 2,662 performance standards violations cited in 1993.
Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1994

Many of the coal mine violations cited by the state officials in 1993 were considered "on-ground" violations. The greatest number of violations involved the construction and maintenance of sediment control devices to control soil runoff into waterways. Backfilling and grading violations involving erosion, highwall settlement, and improper placement, were the second leading cause of coal mining violations in the state. A majority of the violations are resolved in a timely manner, according to the federal Office of Surface Mining.

Figure 9

Coal Mining Water Violations in Kentucky by Type

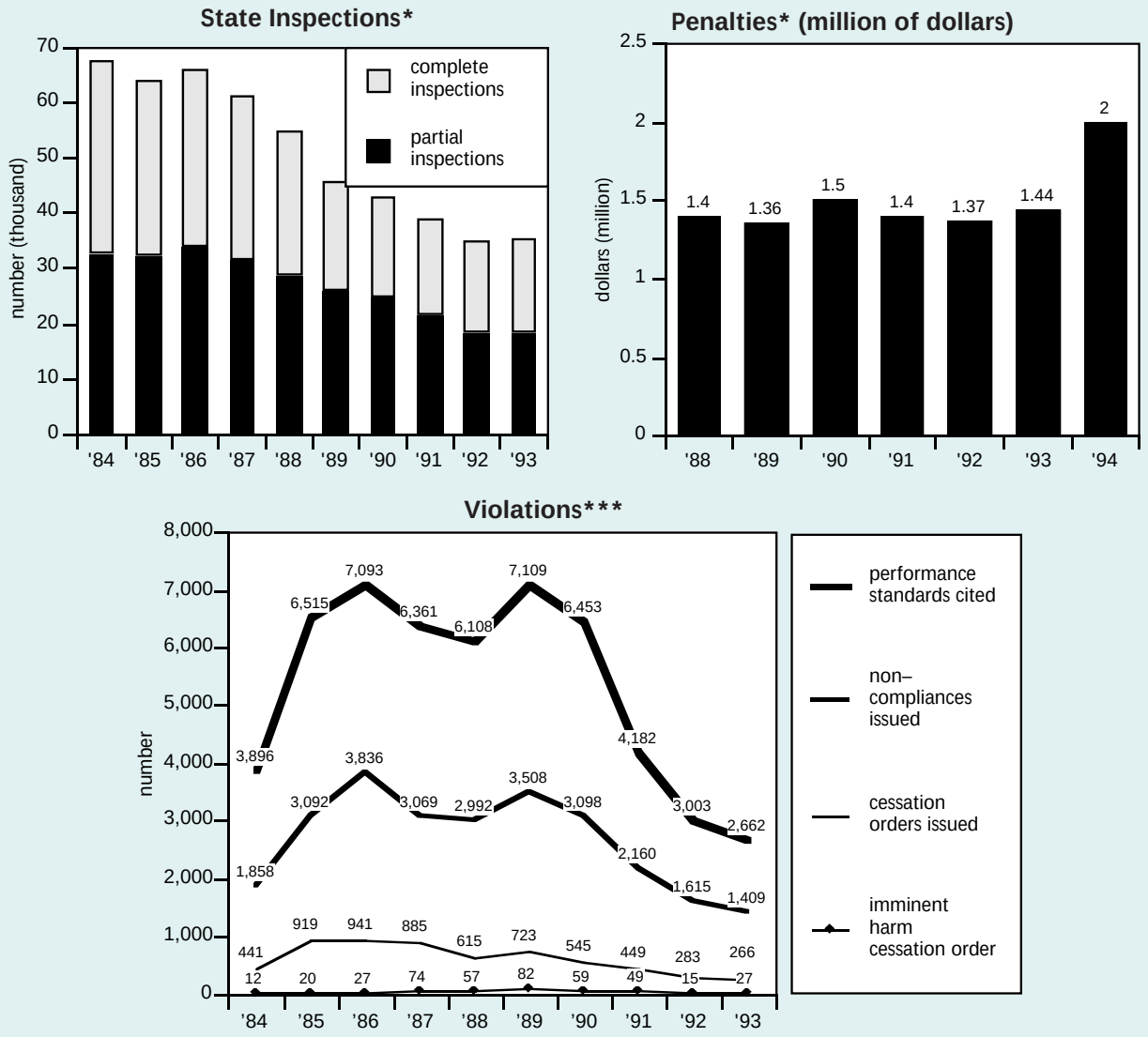


[1]Hydrologic resources - violations concerning drainage, discharge, or anything which may contaminate the water systems associated with the permitted area. [2]Water monitoring - violations concerning sampling and analyses of surface and groundwater associated with and affected by a permitted area. [3]Effluent limits - violations concerning substandard discharges which are required to be reported under a KPDES water discharge permit. [4]Water quality - violations concerning substandard discharges and discharges which have not passed through an approved sediment control facility.
Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1994 ; Kentucky Division of Water, Kentucky Reports to Congress on Water Quality, 1992-94

The number of water violations cited at mine sites has increased in recent years as state officials step up enforcement of water quality standards and requirements. Despite these efforts, coal mines continue to impair water quality in five river basins—the Big Sandy, Kentucky, Green, Upper Cumberland, and Tradewater. During 1992-93, 804 miles of monitored streams and rivers were impacted by pollution attributed to active or abandoned coal mines compared to 317 miles in 1990-91. The increase is attributed to additional monitoring in the Big Sandy River Basin.

Figure 10

Coal Mining Compliance and Enforcement Measures



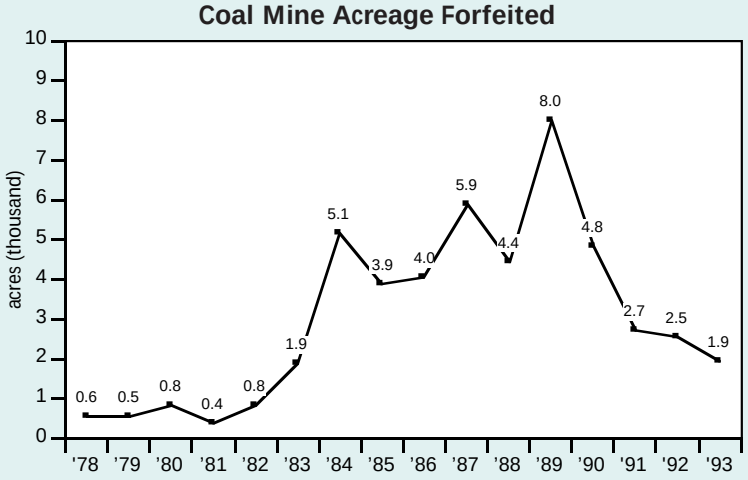
**Includes 8 partial and 4 complete inspections per active coal mine permit each year. Data also include inspections of inactive and abandoned mines and facilities. **By fiscal year, includes fines paid and penalties collected from current and previous year cases. ***Performance standards are specific standards that must be met according to state and federal rules. Noncompliance document that cites violations, remedial measures, and schedules for completion of actions. Cessation orders require operator to cease operation for failure to abate violation and until violation is corrected. Imminent harm cessation order requires operator to cease operations due to imminent harm or potential danger to the public and environment. Source: Kentucky Department of Surface Mining Reclamation and Enforcement; Division of Administrative Services, 1994*

The Kentucky Department of Surface Mining assumed primary authority to enforce the provisions of the federal surface mining law in 1982. The number of coal mine violations cited in 1993 at 1,000 active underground and 1,177 surface mine operations and other related activities permitted in the state has declined significantly since it reached its high in 1989. The decline reflects improved industry compliance with environmental rules. Other contributing factors to the decrease in violations include a reduction in the number of mines, the state's enforcement program which resulted in dramatic increases in violations in the past especially on interim program and 2-acre sites for failure to reclaim, and the elimination of illegal wildcat mines. Most violations are resolved in a timely manner as indicated in the fact that only 9% resulted in cessation orders in 1993.

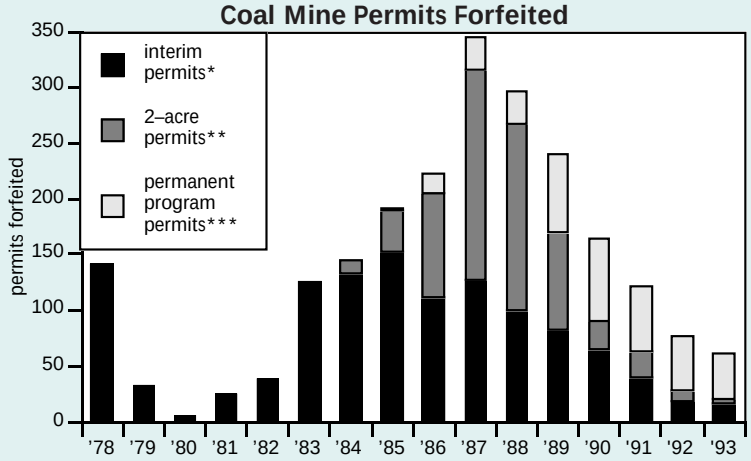
Figure 11

Coal Mine Bond Forfeiture Trends

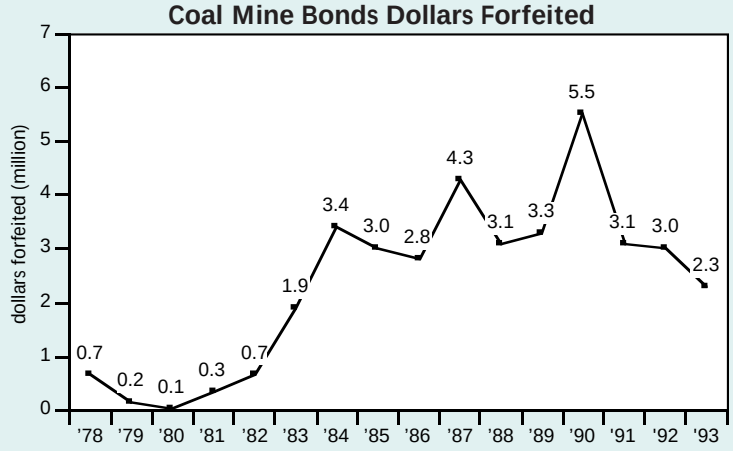
Coal Mine Acreage Forfeited



Coal Mine Permits Forfeited



Coal Mine Bonds Dollars Forfeited



**Interim permits - issued to coal mines in operation from 1978 to 1982. **2-acre permit exemptions - issued to 2-acre mine operations from 1982 to 1987 which exempted operations from performance standards. The 2-acre exemption was repealed in 1987 due to mining abuses. ***Permanent program permits - cover operations that were active on or that began after 1982.*

Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1994

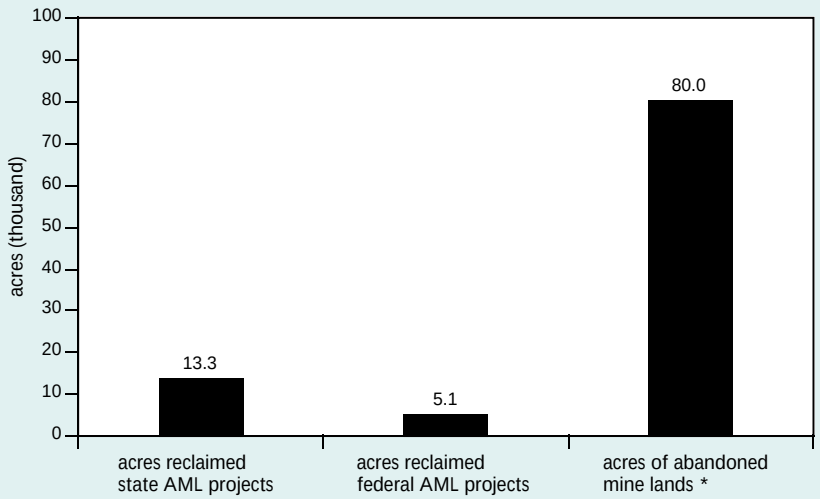
All coal mines are required to post reclamation bonds to assure money is available to reclaim the site. When a coal operation fails to correct a violation it may result in the forfeiture of the reclamation bond. Once a bond is forfeited the state assumes the responsibility of reclaiming the site. Since 1982, 43,259 acres of coal mines have been forfeited in Kentucky. Of these 30,284 acres have been reclaimed by the state with the remainder awaiting reclamation.

The number of coal mine permits forfeited is declining as industry compliance improves and 2-acre and older "interim" operations are addressed. Permanent program mine forfeitures, operations active after 1982, have been reduced from 74 in 1990 to 40 in 1993.

Concern has been expressed by the federal Office of Surface Mining whether coal mine bonds in Kentucky were sufficient to complete reclamation on forfeited sites. A 1993 study conducted by an panel of industry, government, and environmental representatives, and commissioned by the state Department of Surface Mining, called for supplemental bonds and the recalculation of some bonds to ensure adequate funds for the reclamation of forfeited mine sites. State officials have implemented several of the committee's recommendations.

Figure 12

Reclamation of Abandoned Mine Lands in Kentucky

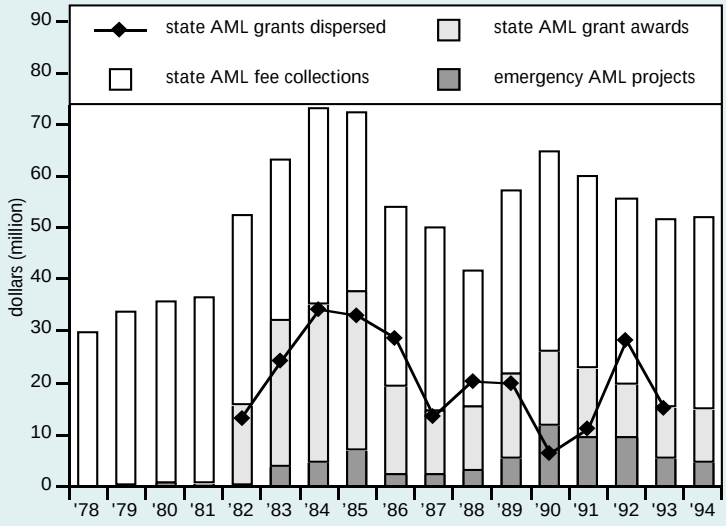


*Note: Includes mine land reclamation projects since 1982. Reclamation activities also include: mine portals closed—1,725; landslides stabilized—2,479; 8 stream restoration projects—470 miles; waterlines complete—47; waterlines under construction or contract —3; waterlines awaiting contract—20; mine fire—23; subsidence—2; maintenance projects—50; highwall eliminated—17,064 feet. *Estimated acreage mined before 1977 potentially eligible for reclamation.*
Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1994

Since 1982, 18,330 acres of abandoned mine land have been reclaimed and hundreds of projects initiated to address related problems. State officials estimate that in excess of 80,000 acres are still potentially eligible for reclamation. The severe winter and flash flooding last year also led to a increase in the number of emergency situations, particularly landslides, at abandoned coal mine sites. During fiscal year 1993-94, 400 complaints related to abandoned mine sites were responded to, more than double of any previous year.

Figure 13

Abandoned Mine Land Funding Trends in Kentucky

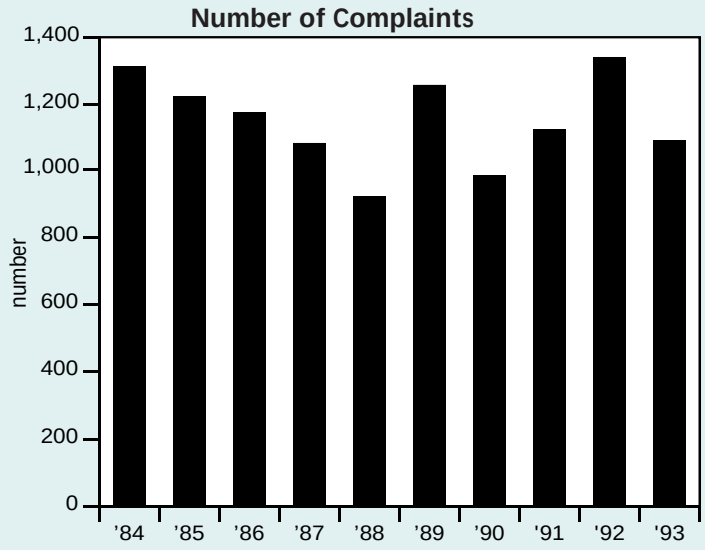


Note: The Abandoned Mine Land (AML) Fund was established in 1978 by the federal government to address pre-law abandoned mine sites that were mined prior to the enactment of the Surface Mining Control and Reclamation Act of 1977. State AML grant funds dispersed include contracts awarded by the state to reclaim old mine lands. Chart does not include federal Soil Conservation Service mine reclamation RAMP projects in Kentucky funded under the AML program which totaled 25.8 million since 1978.
Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1994

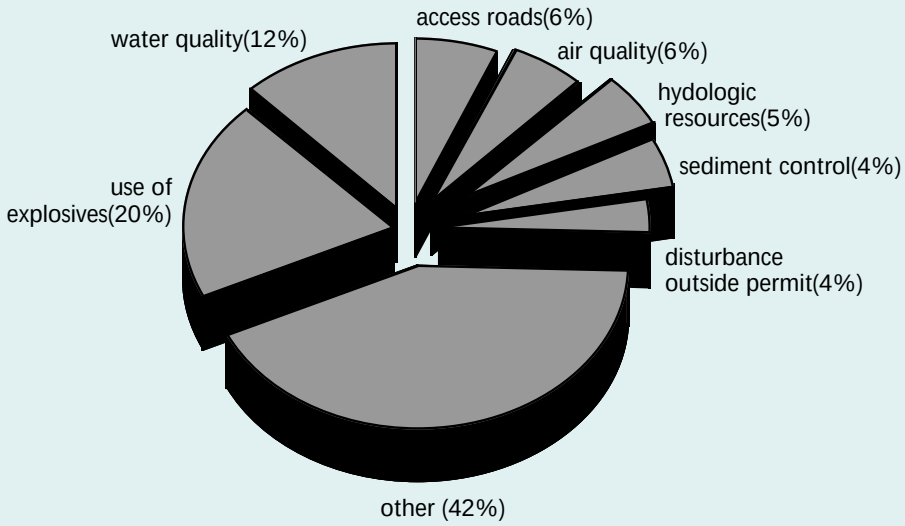
Kentucky relies on the federal Abandoned Mine Land Fund to reclaim old mine sites. The fund is financed with a nation-wide coal production fee ($0.15 a ton for under-ground and $0.35 per ton for surface mined coal). Grants are then appor-tioned back to states for coal mine reclamation purposes. The amount of Abandoned Mine Land Fund monies allocated back to Kentucky has declined steadily since 1984. During 1994, Ken-tucky received $10.3 million to reclaim old mine sites and $5 million for emergency mine land projects, about 41% of the $36.8 million it paid into the fund that year.

Figure 14

Citizen Complaints Regarding Coal Mining Activity in Kentucky



Alleged Violations from Citizen Requests for Inspections (1993)*



**Total citizen requests for inspections for 1993 was 1,270.*

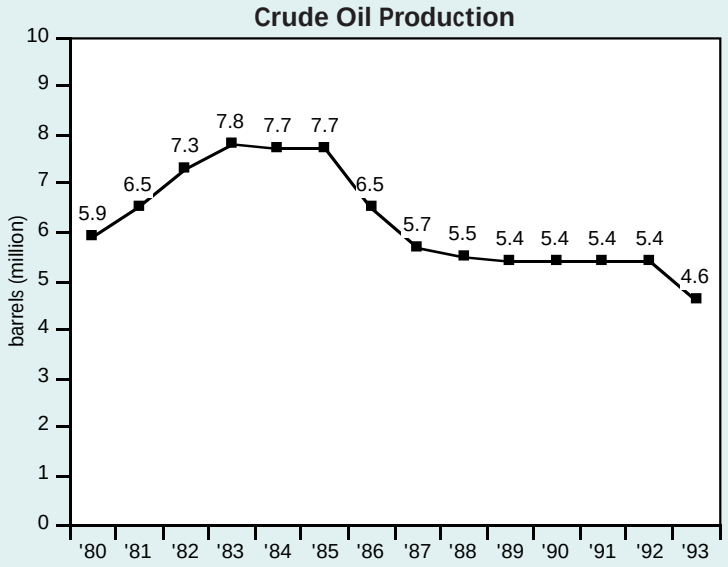
Source: Kentucky Department for Surface Mining, Reclamation and Enforcement, 1994

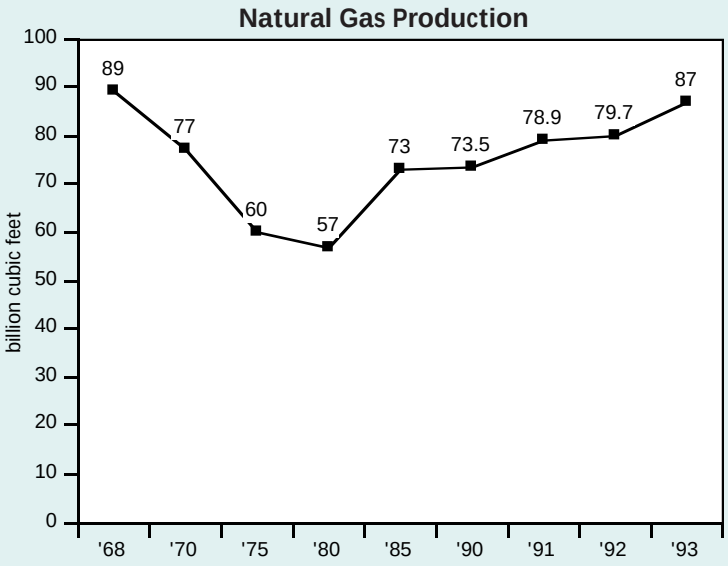
State surface mine officials continue to respond to numerous citizen complaints regarding coal mining activities in the state. A majority of the complaints, 86%, are from Eastern Kentucky where most of the coal is mined. Generally, less than 10% of these complaints result in enforcement action, according state Department of Surface Mining officials.

II. Oil and Natural Gas Indicators

Figure 15

Oil and Gas Production in Kentucky



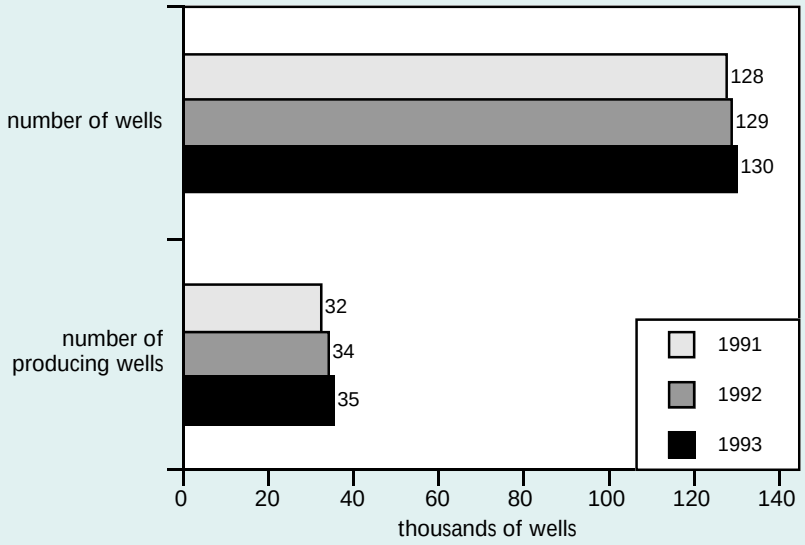


Source: U.S. Department of Energy, Energy Information Administration, State Energy Data, 1991; Kentucky Geological Survey, 1994

Oil and natural gas reserves occur throughout much of west, south-central, and east Kentucky. The production of oil in the state continues to decline due to depressed prices and the cost of production. Natural gas production is increasing primarily due to tax credits recently enacted at the federal level. To date, 741 million barrels of oil and 4,489 billion cubic feet of natural gas have been produced in the state.

Figure 16

Number of Oil and Gas Wells in Kentucky

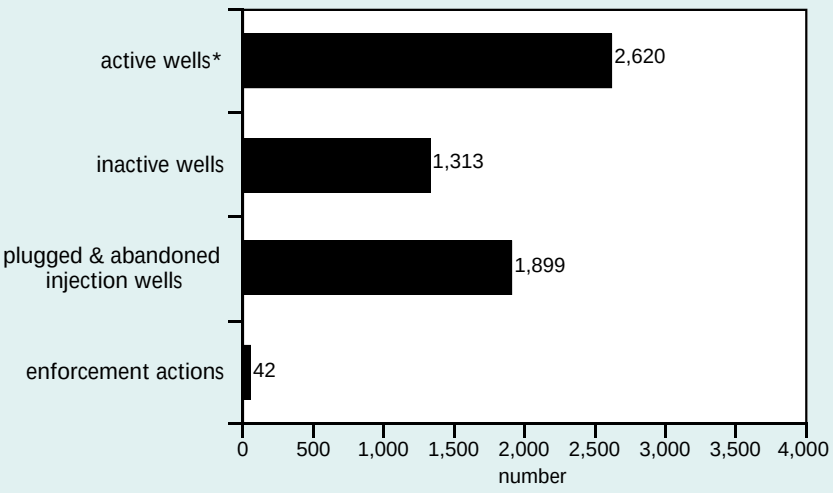


Source: Kentucky Department of Mines and Minerals, 1994

There are an estimated 130,000 oil and gas wells in Kentucky. In 1993, more than 23,500 oil wells operating in 59 counties produced 4.6 million barrels, ranking the state 20th in the nation in oil production. During that year, 12,836 natural gas wells in 32 counties produced 87 billion cubic feet. Kentucky ranks 18th in the nation in the volume of natural gas produced.

Figure 17

Oil and Gas Brine Injection Wells in Kentucky (1994)



Note: Based on Class II underground injection surface facilities permitted or permitted-by-rule.

Source: U.S. Environmental Protection Agency, Underground Injection Program, Region IV, 1994

Salty brine water, extracted during oil drilling, can degrade streams and is toxic to aquatic life. The U.S. EPA regulates underground disposal of brine at 2,620 active injection wells in Kentucky. The greatest environmental problems occur at older and illegal or inactive injection wells, according to U.S. EPA officials. Enforcing injection well requirements to prevent environmental problems is a challenge given the number of wells and the fact the agency has only four inspectors to monitor compliance in the state.

Figure 18

Chloride Pollution in Monitored Streams in Kentucky by River Basin

River Basin	Miles Not Supporting Uses 1987*	1989*	1991	1993	% Of Nonsupport Problem (1993)
Licking River	13	36	37	32	10%
Kentucky River	60	83	44	84	15%
Big Sandy	66	34	0	9	2%
Little Sandy	31	12	12	12	51%
Green River	0	52	18	0	-
Upper Cumberland	21	59	3	0	-
Total	**191**	**276**	**114**	**137**	

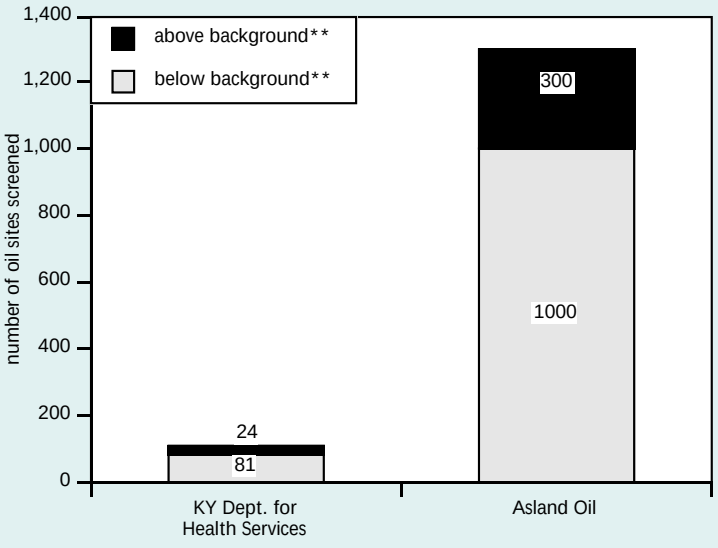
**Includes monitored streams partially supporting and not supporting uses due to chloride pollution.*

Source: Kentucky Division of Water, Report to Congress on Water Quality, 1988-1994

Chloride pollution from oil drilling operations is impacting water quality in four river basins. Brine and other water discharges from drilling operations and related production facilities, such as 9,235 registered oil storage tanks, are regulated by the Division of Water through KPDES water permits and regulations. Stepped up enforcement of water quality standards at oil drilling operations, better industry compliance, and a decline in crude oil production have resulted in a decrease in the levels of chloride pollution at 19 of the 21 monitored streams during the past few years.

Figure 19

Oil Field Sites Tested for Naturally Occurring Radioactive Material in Kentucky*



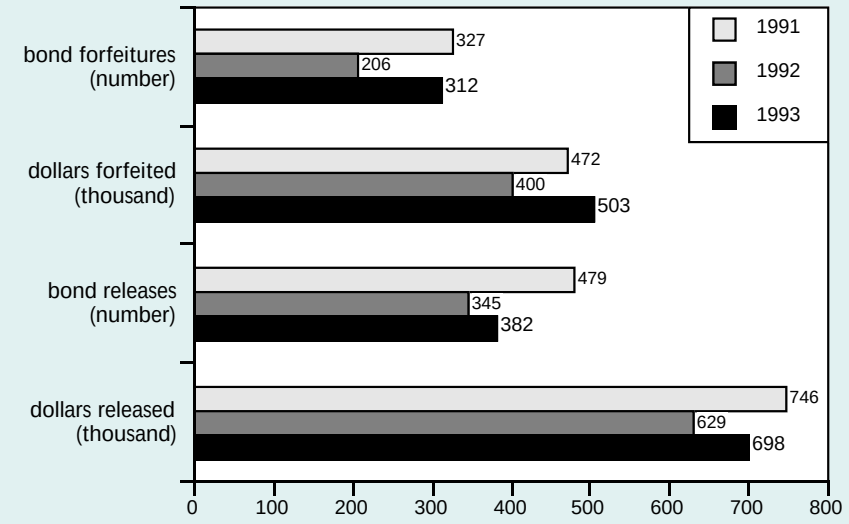
**Based on tests conducted by the Kentucky Department for Health Services and Ashland Oil in the Martha Oil Field in Johnson and Lawrence counties during 1994. **Background levels of 20 Micro Rs. Those sites with levels above background are considered contaminated.*

Source: Kentucky Department for Health Services, Division of Radiation, 1994

Naturally occurring radioactive material (NORM) at oil sites was first discovered in 1988. The radiation occurs naturally underground but was brought to the surface when water was used to force extra oil out of wells in the mid 20th century. The extent of NORM contamination is not known. However, 23% of the sites tested in Lawrence and Johnson counties had contamination problems. The Department for Health Services is in the process of developing standards for the disposal and cleanup of NORM materials.

Figure 20

Oil and Gas Bond Forfeitures and Releases in Kentucky

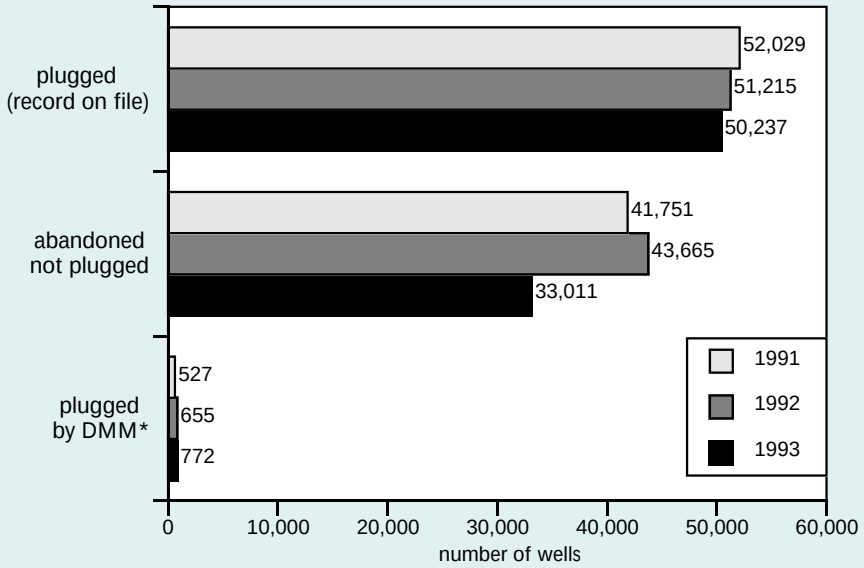


Source: Kentucky Department of Mines and Minerals, 1994

Like coal mines, oil and gas operations must post financial bonds to assure the proper plugging of wells to prevent groundwater contamination. In 1993, nearly as many oil and gas bonds were forfeited as were released. The high rate of bond forfeitures is attributed to more aggressive state enforcement of well plugging requirement, particularly at older operations.

Figure 21

Abandoned Oil and Gas Wells in Kentucky



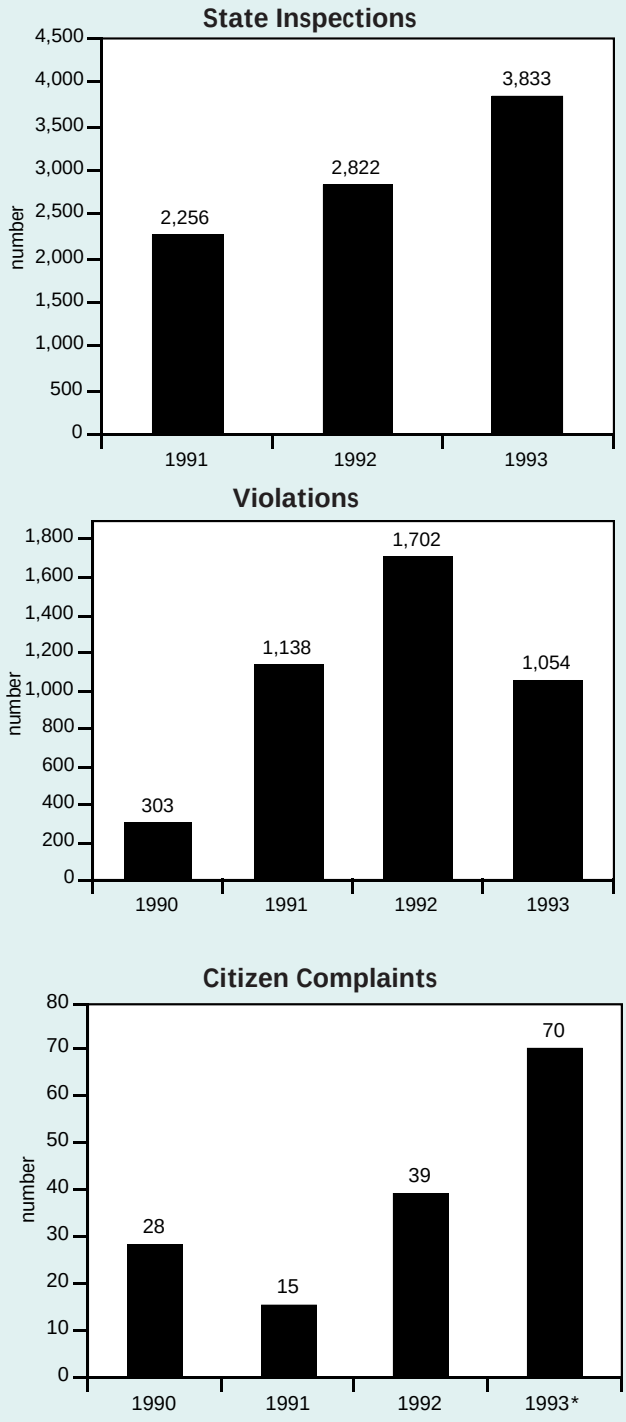
**Cumulative yearly number of abandoned oil and gas wells plugged by the Kentucky Department of Mines and Minerals, Division of Oil and Gas, since 1986.*

Source: Kentucky Department of Mines and Minerals, 1994

The Department of Mines and Minerals estimates that there are 33,000 abandoned unplugged oil and gas wells in Kentucky. The department continues to locate, prioritize, and plug oil and gas wells based on environmental threats. On average, about 100 wells have been plugged yearly since 1986 using the interest monies accrued through oil and gas bond forfeitures.

Figure 22

Oil and Gas Enforcement and Compliance Measures



More formal interoffice complaint form developed by the Division of Oil and Gas in 1993 which may account for increase in the number of complaints. Source: Kentucky Department of Mines and Minerals, Division of Oil and Gas, 1994

The Department of Mines and Minerals is responsible for monitoring oil and gas drilling operations in the state. They report that most environmental problems occur at older crude oil wells in Western Kentucky and small independently-owned natural gas wells in Eastern Kentucky. Because the department does not have the authority to assess fines against violators it must rely on bond forfeitures as its primary enforcement tool. The number of illegal oil and gas drilling operations continue to decline due to more aggressive state efforts to prosecute violators. In the past 18 months the department has pursed legal actions against seven illegal drilling operations all of which resulted in criminal convictions.

Chapter 7

Energy

Energy

Relatively abundant and inexpensive energy supplies have improved our quality of life in terms of greater mobility, better home heating and cooling systems, and access to an ever increasing number of modern conveniences. However, these benefits have not come without costs. Energy production and consumption are now linked to some of the key environmental issues of the day including global warming and acid rain.

Measuring patterns of energy use is the focus of this chapter. Indicators are included to track trends in energy consumption, transportation activities, energy prices, and expenditures in the state. These measures provide a general picture of the challenges Kentucky faces in meeting an energy future that is efficient and sustainable.

Highlights

- Transportation accounts for more than one-third of all energy used in the state during 1992. The typical Kentuckian traveled alone to work and averaged 10,451 vehicle miles that year.
- Electricity supplies 35% of the energy used for industrial, commercial, and residential purposes during 1992, followed by natural gas (28%), petroleum (25%), and coal (12%).
- Most Kentuckians are using about the same amount of energy in their homes as they did in the 1980's. Energy efficient appliances and weatherization of homes have likely helped offset increases.
- Kentuckians spent nearly $7 billion annually during recent years for energy used in commercial, industrial, transportation, and residential activities. Energy expenditures currently account for seven percent of the average Kentuckians income.
- Energy conservation measures are increasing in the state but are still quite limited. Eleven Kentucky companies and government agencies participate in the national Green Lights Program to reduce energy use and costs associated with lighting.
- Relatively little energy is produced from renewable sources in Kentucky. About five percent of the electricity used here is generated by hydropower. Thirty industries are using wood residue for fuel.

I. Energy Consumption Indicators

Indicators reveal that during the early 1990's, energy consumption for commercial, residential, transportation, and industrial purposes continued the increasing trends that have been occurring since before the 1960's in Kentucky. The trends reflect the state's expanding economic activity, larger population, and growing demand and availability of electricity.

The use of electricity continued the steady increase observed during the last thirty years. Consumption of electricity rose 164% during the last three decades. In general, electricity is replacing other fuels for industrial, residential, and commercial use. This Kentucky and national trend is expected to continue into the future.

Industrial Use. Industrial energy consumption grew slightly between 1990 and 1992, following a 52% growth during the last three decades. Kentucky currently ranks 13th in the nation in industrial energy use due to energy-intensive industries including paper and chemical companies. Petroleum and electricity are the dominant energy sources used by industries in the state.

Residential Use. The amount of energy used in our homes continues the same increasing trends reported between the 1960's and the 1990's when total consumption for residential use rose 52%. Per capita consumption shows a 38% increase during that period. Expanding population and growth in the number of single-family homes, from 983,665 households in 1970 to 1,379,782 households in 1990, likely account for much of the rise in residential energy consumption.

The trend toward greater use of electricity and natural gas to heat and light homes during the early 1990's continues. Household electricity consumption has risen steadily since 1965. Natural gas use declined between 1970 and 1990, but began rising again between 1990 and 1992 replacing petroleum for home heating and cooling.

Renewable Energy. Relatively little energy in Kentucky is generated by renewable sources, which include hydropower, solar, biomass, wind, and geothermal energy. In 1992, seven hydropower plants generated 5% of the electricity consumed in the state. Increasing attention has been given to the use of biomass as an alternative fuel in Kentucky. Currently, an estimated 30 wood-related businesses are fueled by wood residues produced at sawmills.

The use of geothermal heating and cooling systems in Kentucky is also increasing. Geothermal systems transfer the Earth's heat (underground temperatures average about 55 degrees Fahrenheit) into a home or other building where it is supplemented with electricity to bring indoor

temperatures to comfortable levels. Geothermal systems work in the reverse for cooling by using the Earth as a heat "sink "during warm summer months.

Some electric utilities are encouraging customers to use geothermal systems along with weatherization and other conservation measures. The combination of these measures can save up to 40% of home energy costs. The Big Rivers Utility Company which serves the northwestern area of the state pays an average of $600 in rebates to a customer who installs a geothermal system. The utility reports that 330 geothermal units have been installed since 1992. East Kentucky Power has provided incentives for 3,500 geothermal units since 1985, three of which have been installed in schools.

Federal, State, and Local Energy Conservation. Energy conservation efforts in the United States have been revitalized with the passage of the national Energy Policy Act of 1992, the federal Clean Air Act Amendments of 1990, and the Intermodal Surface Transportation Act. Energy conservation and fuel efficiency are key elements in the nation's strategies for addressing energy needs and reducing air pollution problems associated with the burning of fossil fuels. The renewed attention follows more than a decade of declining federal incentives for conservation programs and alternative fuels research and development.

President Clinton released the "Climate Change Action Plan" in 1993 which consolidates many of the mandates in the three federal acts mentioned above. The plan outlines new actions to reduce the air pollution problems associated with fossil fuel combustion and other emissions.

Under the plan, states will be required to inventory, reduce, and mitigate greenhouse gas emissions which are associated with increasing global temperatures. Eight states have completed greenhouse gas inventories. The Kentucky Division of Energy received a grant from the U.S. Environmental Protection Agency to conduct a greenhouse gas inventory and policy analysis that is scheduled to be completed by June 30, 1995.

Several provisions of the Energy Policy Act will impact the state. These include requirements for the review of residential and commercial building energy codes, and the development of new efficiency standards for homes, offices, and certain equipment commonly used in commercial buildings.

The Kentucky Division of Energy oversees several programs to encourage conservation and energy efficiency. The Institutional Conservation Program offers technical assistance to schools, hospitals and other institutions interested in conducting energy audits and employing conservation measures. Since 1980, 399 facilities in Kentucky have participated in the program. During 1993, the state received $1.25 million in federal funds to support these efforts. The average facility participating in the program achieved a 25% reduction in total energy consumption by implementing the recommended strategies. These strategies often include weatherization and replacing heating systems and lighting fixtures with more efficient models.

The Division of Energy drafted and promoted legislation during the 1994 session of the Kentucky General Assembly to require energy conservation measures at state-owned buildings. The savings were estimated at $10 million in annual energy costs. The bill passed the House unanimously, but time did not permit action by the Senate.

Many local efforts are also achieving success in reducing energy consumption and improving efficiency, while at the same time saving a great deal of money. For example, during 1993 and 1994, the Louisville and Jefferson County Metropolitan Sewer District saved approximately $220,000 in energy costs by adopting energy conservation measures recommended by the Louisville Resource Conservation Center, a nonprofit consulting group. These measures included changing rate classes to take advantage of off-peak rates, improving lighting efficiency, weatherization, and using infrared heating for repair shops.

Another example is the energy conservation project conducted by the Division of Energy at the Kentucky Dam Village State Park during 1992. The park replaced traditional lighting with compact fluorescent lamps, which are 75% more efficient. The project resulted in savings of nearly $4,000 for direct lighting costs alone in the main lodge during a 19-month period.

Green Lights Program. Lighting alone accounts for an estimated 25% of all energy consumed nationwide. The U.S. Environmental Protection Agency established its "Green Lights" Program in 1991 to encourage voluntary measures to reduce energy consumption, costs, and the pollutants associated with burning fossil fuels for lighting purposes.

The program has the support of 1,575 "partners" nationwide, 11 of which are located in Kentucky. Ashland Petroleum has been an active participant in the program. The Ashland facilities located in Kentucky have saved several thousand dollars on lighting costs and expect to achieve more as the program is fully implemented. Through the Green Lights initiative, the company also reduced pollutants associated with air quality problems and global climate change by more than 75,000 pounds at the Kentucky sites, and by 10 million pounds company-wide.

Camping World, a national chain with facilities in Kentucky, reports the program is a good source of information about energy technologies. Energy-saving measures implemented by the company are saving a minimum of 20% of lighting costs. Camping World is testing additional

technologies such as occupant sensors that will further reduce costs.

Demand Side Management. The 1992 Energy Policy Act authorizes grants to state regulatory authorities and incentives to electric utilities to encourage "demand side management" and "integrated resource planning." Demand side management incorporates a wide range of measures that utilities employ to reduce and redistribute energy demand, avoid building new power plants, and curb polluting emissions. Integrated resource planning (IRP) considers both demand and supply options available to utilities when planning for future electricity needs. Kentucky has had regulatory authority to require IRPs from utilities since 1990, under the jurisdiction of the Kentucky Public Service Commission.

Kentucky has six major electric utilities which supply 70% of the electricity sold in the state. Each of these utilities is required to submit IRPs to the Kentucky Public Service Commission that reflect demand and supply forecasts and related issues. In recent years, these plans have focused attention on addressing the 1990 Clean Air Act Amendments. The next round of IRPs (due in 1996) are expected to place additional attention on conservation and efficiency initiatives mandated or encouraged under the Energy Policy Act.

II. Transportation Indicators

Transportation accounts for more than one-third of all energy used in the state. Kentuckians consumed 69 million barrels of petroleum for transportation activities during 1992, an increase of 6% since 1990. The short-term rise is typical of the long-term trend which reflects a 176% increase in petroleum consumption since 1960.

Today's mobile society has taken a toll on the economy and the environment. Louisville, Northern Kentucky, and other urban areas of the state have experienced air pollution problems caused by vehicular emissions. National forecasts indicate transportation energy consumption will grow 28.5% between 1990 and 2010, although many factors, such as petroleum prices and the success of alternative fuels, may influence predicted trends.

Automobiles and Energy Efficiency. The number of passenger vehicles registered with the state have increased 35% since 1970 and now number 1.8 million. Kentuckians have also nearly doubled the average number of miles driven each year for personal travel since 1970. In 1993, the average person traveled nearly 10,500 miles. Although total petroleum consumption and the number of miles traveled have increased, the amount of gasoline consumed per person has generally been declining since 1975 as a result of improved efficiency in vehicles.

New federal energy conservation strategies focus attention on improving efficiency because the rising number of vehicles on the road and increasing number of miles traveled are offsetting the gains made in fuel efficiency. The U.S. Department of Energy predicts a 44% increase in personal vehicle fuel efficiency by the year 2010 due to new technologies, conservation incentives, and other factors.

Alternative Fuels. The use of cleaner, renewable fuels is an important component of federal strategies to curb air pollution, reduce U.S. dependence on foreign oil, and control emissions from burning fossil fuels that are believed to be associated with acid rain and global warming. The Energy Policy Act of 1992 requires state fleets to purchase vehicles powered by alternative fuels such as ethanol, methanol, natural gas, propane, electricity, or biofuels.

New state government fleet purchases in the metropolitan areas of Louisville, Lexington, Northern Kentucky, Ashland, and Henderson must include 10% alternative fuel vehicles in 1996, increasing to 75% of total fleet purchases by the year 2000. The Division of Energy has recommended the state apply these requirements to all state vehicle purchases and further study the economic and environmental merits of available alternative fuels.

The Clean Cities Program is a voluntary program established by the U.S. Department of Energy to reduce air pollution problems by increasing use of alternative transportation fuels to improve air quality and reduce dependence on imported oil. The City of Louisville and Jefferson County have created a partnership involving local businesses and government agencies to meet the criteria needed to become the nation's 19th "Clean City." The partnership was facilitated by the Kentucky Clean Fuels Coalition, a public/private partnership that promotes alternative fuels to reduce pollution problems. The criteria for becoming a "Clean City" includes committing to accelerate the use of alternative fuels in fleet vehicles and promoting partnerships to create the infrastructure needed to support alternatively fueled vehicles.

The use of ethanol as an alternative fuel is predicted to increase nationwide during the next decade. Ethanol produced from corn and other biomass is used as a clean burning fuel supplement that is blended with gasoline to produce "gasohol." Gasohol is higher in oxygen content and burns cleaner than gasoline.

The American Farm Bureau estimates farmers and other agricultural businesses could annually earn as much as $1.5 billion if ethanol use was significantly expanded. The future of gasohol in the U.S. and Kentucky will also be impacted by the national Energy Policy Act due to provisions designed to curb air pollutants associated with smog and global warming.

The amount of gasohol used in Kentucky can not be accurately determined for recent years due to changes in reporting requirements for gasoline suppliers. Federal tax

credits were made available to companies that supplied gasohol during the 1980's. However, the credits ended late in the decade and companies were no longer required to report sales to the U.S. Department of Energy, although some did so voluntarily. Based on this information, the state currently ranks ninth in the nation in terms of gasohol consumption.

The Clean Air Act Amendments require the use of oxygenated fuels in areas that fail to achieve the health-based air quality standards for ozone (smog). The state opted in 1994 to use reformulated gasoline, a petroleum product, rather than ethanol blended gasoline to meet clean air requirements in two areas of the state with ozone air pollution problems, Jefferson County and Northern Kentucky.

Carpooling and Public Transportation. The 1990 census reveals that 1.2 million Kentuckians use personal vehicles for transportation to and from work. Although carpooling gained in popularity during the 1970's and 1980's primarily due to escalating fuel costs, fewer Kentuckians report sharing rides during the 1990's. The use of personal vehicles by one person increased 64% from 1970 through 1990.

The number of people using public transportation for work-related travel dropped by more than one-third between 1980 (367,000) and 1990 (239,000). The rising number of people in the work force, rural commuters, funding cuts in energy conservation programs, and higher personal incomes have likely resulted in the decline of carpooling and public transportation use.

III. Energy Price and Expenditure Indicators

Kentuckians spent nearly $7 billion annually during recent years for energy used in commercial, industrial, transportation, and residential activities. It is estimated that the average Kentuckian spends seven percent of their income for energy consumption.

Expenditures and Costs. Transportation-related expenditures accounted for 41% (nearly $3 billion) of the $7 billion spent for energy in 1992. Transportation expenditures increased at a greater rate than any other sector between 1988 and 1992.

Average gasoline prices in Kentucky have greatly fluctuated during the last two decades due to supply shortages, import prices, and other factors. The highest average gasoline prices were recorded in 1981 when average pump prices reached $1.34 per gallon, compared to $1.12 in 1994.

New, cleaner burning gasoline is now required to be sold to control smog pollution in some areas of Kentucky, including Jefferson County, Northern Kentucky, and the Ashland area. The cleaner reformulated gasoline, mandated by the Clean Air Act Amendments of 1990, is expected to cost an average five to ten cents more per gallon in Kentucky. Pump prices in these areas rose an average three to five cents per gallon in these areas during late January 1995 as the new gasoline was distributed by wholesale suppliers.

The cost of energy strongly influences consumption patterns. The price of petroleum, natural gas, and coal increased during the "energy crisis" era between 1970 and the mid-1980's. However, if adjusted for inflation, the price increase would be less significant.

Energy costs have since stabilized or declined. The decline in the price of petroleum during the 1990's is due to world market conditions involving plentiful oil supplies and a lack of OPEC influence on these supplies. Natural gas and coal prices in the state were also lower during this decade as a result of market competition and more cost-effective technologies.

Total electricity expenditures for residential, commercial, and industrial purposes in Kentucky continue to increase as well. Expenditures increased from $354.9 million in 1970 to $2.78 billion in 1992 as a result of increased demand.

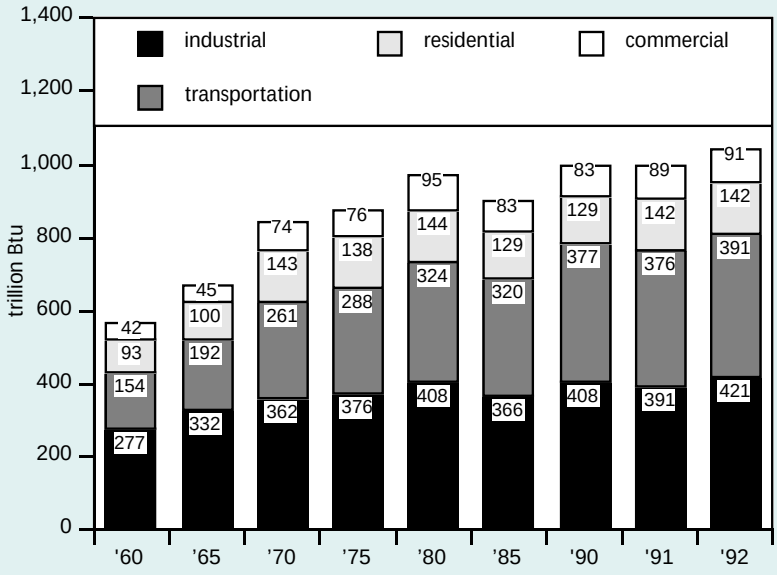
Controlling air pollution from coal-fired power plants, Kentucky's principle source of electricity, has also added to the cost of producing electricity. Some utilities have imposed environmental surcharges on customers and others are seeking approval. For example, Kentucky Utilities recently imposed a 2% charge on customers due to costs of controlling sulfur dioxide as required under the federal Clean Air Act Amendments of 1990. The surcharge, however, is being challenged in court by the Kentucky Attorney General and ratepayers. The Attorney General contends that rates already allow recovery of these costs. Big Rivers Electric has received approval for adding environmental surcharges and Louisville Gas and Electric is currently seeking approval for environmental controls that are estimated to be $89.9 million. The charges would add $0.52 to the average monthly residential electric bill.

Despite these costs, average electric rates in Kentucky are still among the lowest in the nation due to the proximity of coal resources. During 1994, the average price per kilowatt hour was 4.6 cents compared to the national average of 7.16 cents. ■

I. Energy Consumption Indicators

Figure 1

Total Energy Consumption in Kentucky



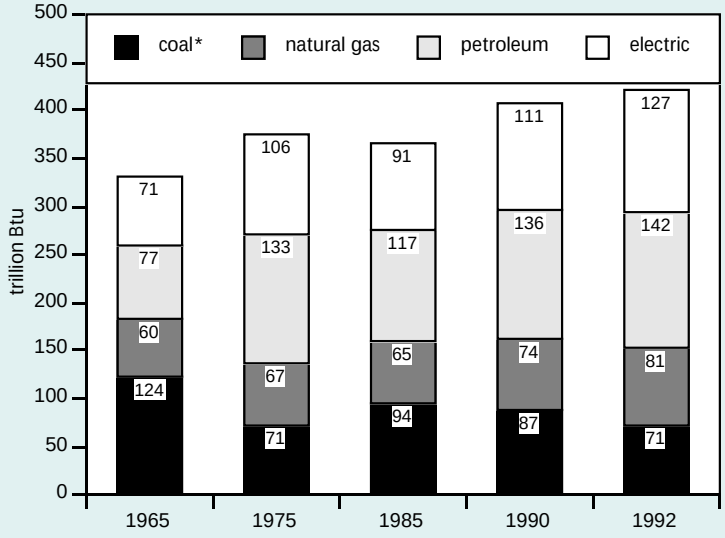
Note: 1992 data most recent available. Data has been refined since the 1992 "State of Kentucky's Environment" report.

Source: U.S. Department of Energy, EIA State Energy Data Reports, 1960-92

Energy consumption is increasing in Kentucky for all use sectors. This reflects the state's expanding economic and residential growth. The greatest increase between the years 1965 and 1992 was energy consumed for transportation, where use rose 154%. This is largely due to increased personal travel and mobility as well as growth in air traffic in the central and northern areas of the state. In the short term, residential energy use grew the most, rising 10%, between 1990 and 1992. Industrial consumption increased 3%, transportation 4%, and commercial use grew 8% during this time period.

Figure 2

Industrial Energy Consumption by Source in Kentucky



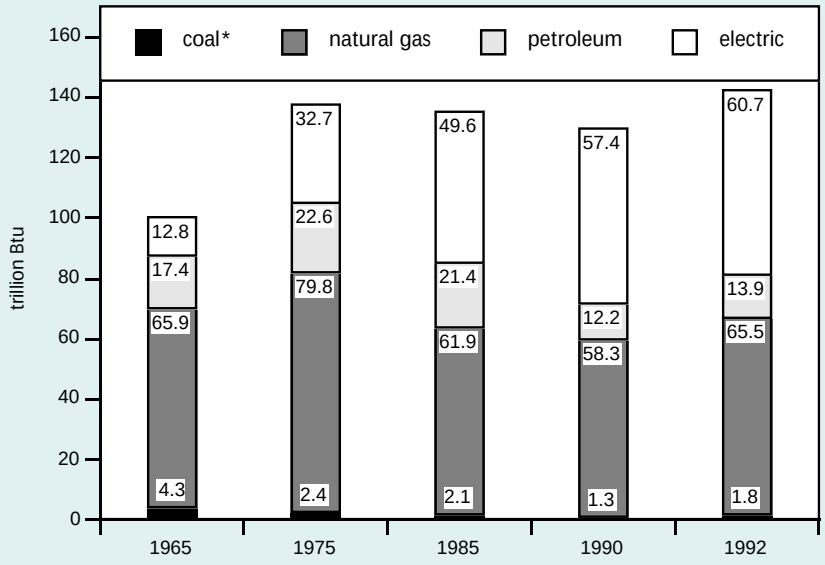
**Coal category is direct use and does not include coal burned to generate electricity.*

Source: U.S. Department of Energy, EIA State Energy Data Reports, 1965-92

Industrial energy use accounted for 40% of the energy consumed in Kentucky during 1992. The state currently ranks 13th in the nation for energy consumption primarily due to energy intensive industries which include paper, aluminum, and chemical companies. Petroleum remains the preferred fuel of the industrial sector. The use of electricity, however, is growing at the greatest rate, increasing 40% between 1985 and 1992.

Figure 3

Residential Energy Consumption in Kentucky by Source

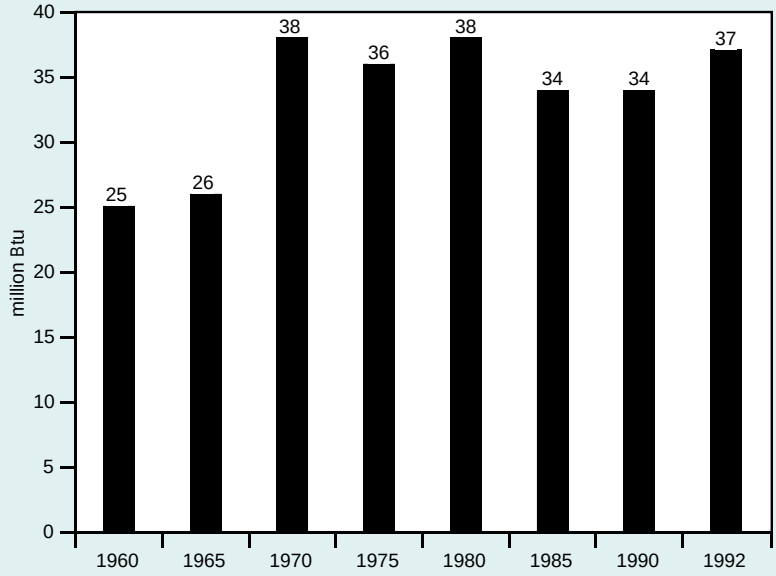


*Note: 1992 data most recent available. *Direct use of coal.*
Source: U.S. Department of Energy, EIA State Energy Data Reports, 1965-92

Natural gas is the greatest source of energy used for residential purposes in Kentucky, followed by electricity. After declining consumption trends from 1975 to 1990, natural gas use increased 6% between 1990 and 1992 as a result of the industry's efforts to market natural gas as a clean-burning fuel and increased availability in the state. The use of petroleum in homes has declined as homebuilders shift toward less expensive and more efficient electricity and natural gas for home heating and cooling.

Figure 4

Per Capita Residential Energy Consumption in Kentucky

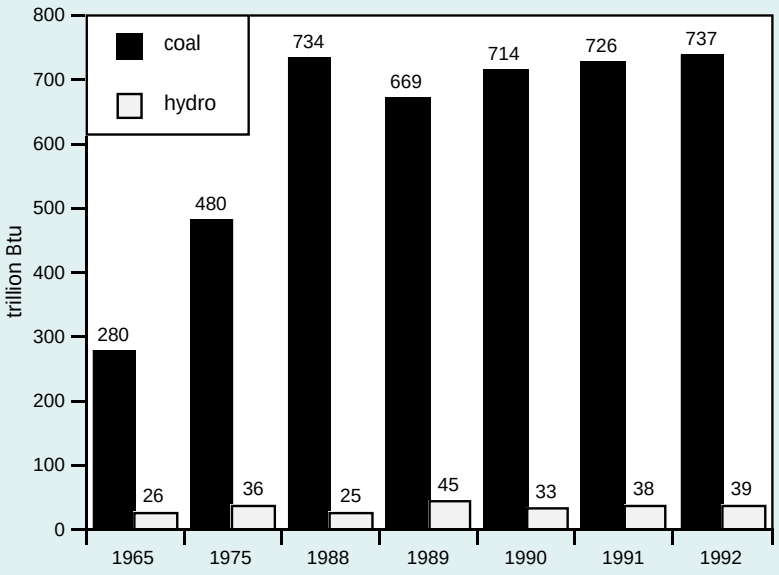


Note: Data have been refined since the 1992 "State of Kentucky's Environment" report. Includes coal, natural gas, petroleum, and electricity. Does not include electricity used during generation and transmission to homes.
Source: U.S. Department of Energy, EIA State Energy Data Reports, 1960-92, State Data Center, 1990 Census.

The total amount of energy used per person for residential purposes grew 32% between 1960 and 1992. The increase is due to the availability of modern conveniences and Kentuckians rising standard of living. However, indicators reveal that per capita consumption has stabilized during the past 22 years. Most energy presently consumed in homes is natural gas and electricity.

Figure 5

Electric Energy Consumption in Kentucky



Source: U.S. Department of Energy, EIA State Energy Data Reports, 1965-92

The use of electricity has markedly increased during the last 30 years in Kentucky. This is due to greater access to electricity and the use of modern "conveniences" such as appliances and air conditioning, as well as expanding economic activity. Most electricity in Kentucky is produced by 21 coal-fired power plants. However, six of these plants produce 70% of the electricity sold in the state. There are also seven hydropower plants located on six waterways producing about 5% of the electricity consumed in the state.

Figure 6

Green Lights Program Participants in Kentucky

Kentucky Participants	County
A-M Electric Company*	Jefferson
Ashland Oil	Boyd
Camping World	Warren
City of Louisville	Jefferson
Highlands Regional Medical	Floyd
J.E. Seagram Corp.	Jefferson
Kentucky Lighting and Supply*	Fayette
Louisville Resource Conservation	Jefferson
Mammoth Cave National Park	Edmonson
Metropolitan Sewer District	Jefferson
Trojan Inc.	Montgomery

**These facilities participate as "allies' that assist in program outreach efforts.*

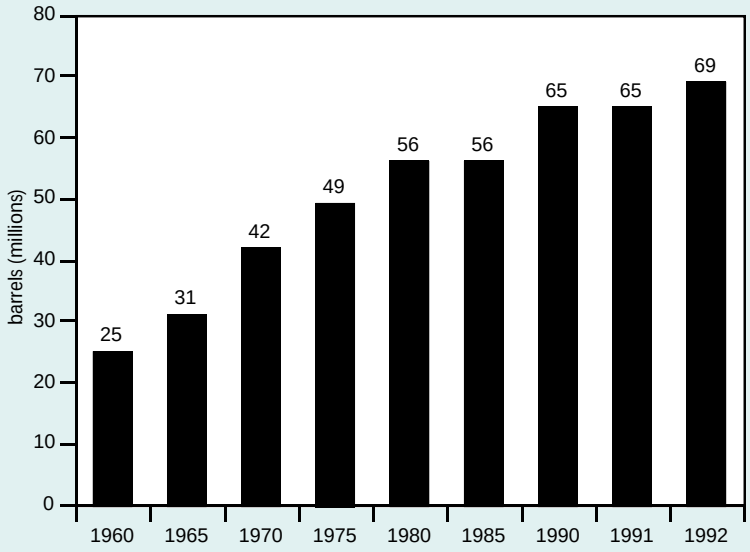
Source: U.S. Environmental Protection Agency, 1994

The U.S. Environmental Protection Agency established its "Green Lights" Program in 1991 to encourage voluntary measures to conserve energy and reduce costs and the pollutants associated with burning fossil fuels for lighting purposes. The program has the support of 1,575 "partners" nationwide, 11 of which are located in Kentucky.

II. Transportation Indicators

Figure 7

Consumption of Petroleum for Transportation in Kentucky



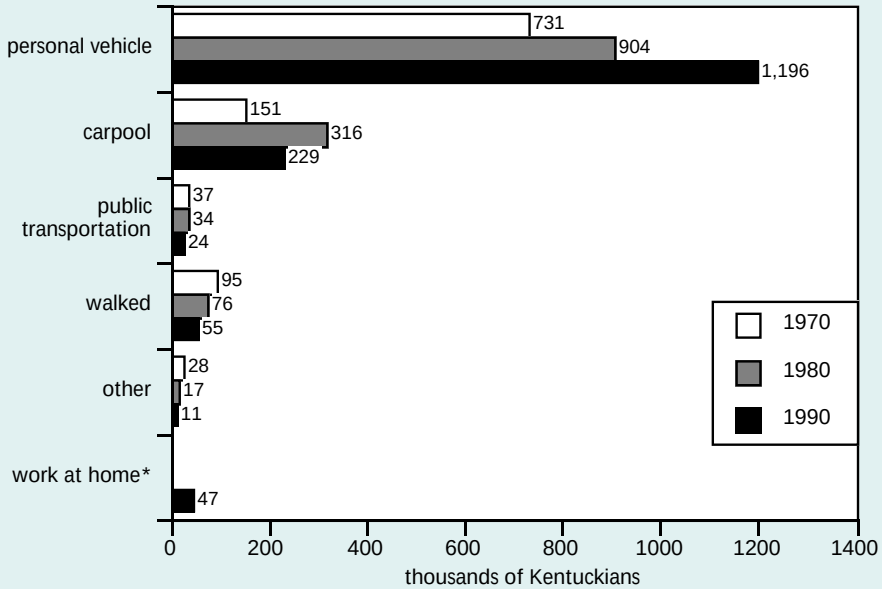
Note: Includes motor gasoline, road oil, jet fuel, distillate fuel, aviation gasoline, kerosene, LPG, lubricants, residual fuel, and miscellaneous petroleum fuels. 1992 data is most recent available. Data has been refined since the 1992 "State of Kentucky's Environment" report.

Source: U.S. Department of Energy, EIA State Energy Data Reports, 1960-92

Kentuckians consume large quantities of petroleum for transportation purposes each year. Petroleum consumption rose 176% between 1960 and 1992. This trend reflects the increased mobility of Kentucky's expanding population. The 6% rise in petroleum use that occurred during the early 1990's is also attributed to the expansion of airports and increased airline traffic in Northern and Central Kentucky.

Figure 8

Modes of Transportation to Work in Kentucky



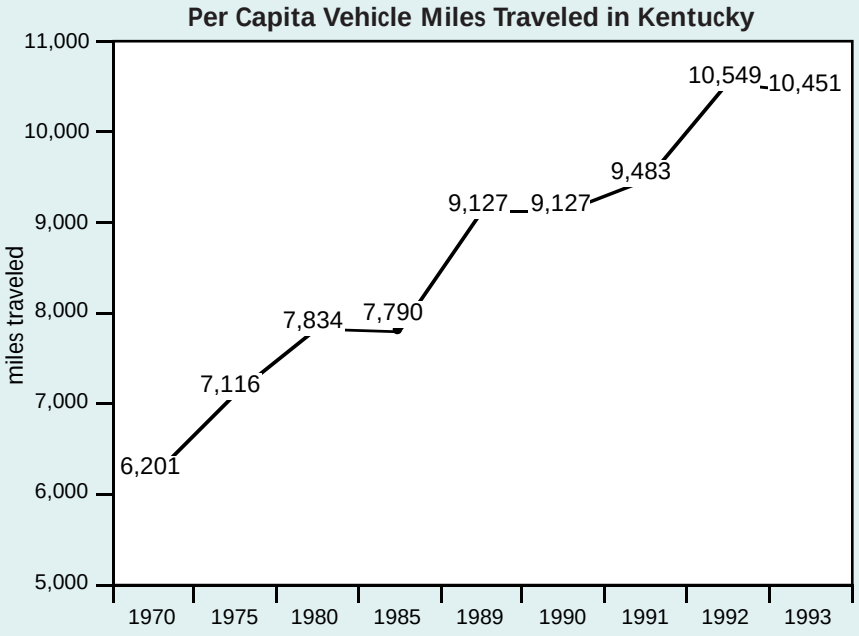
**Earlier data unavailable.*

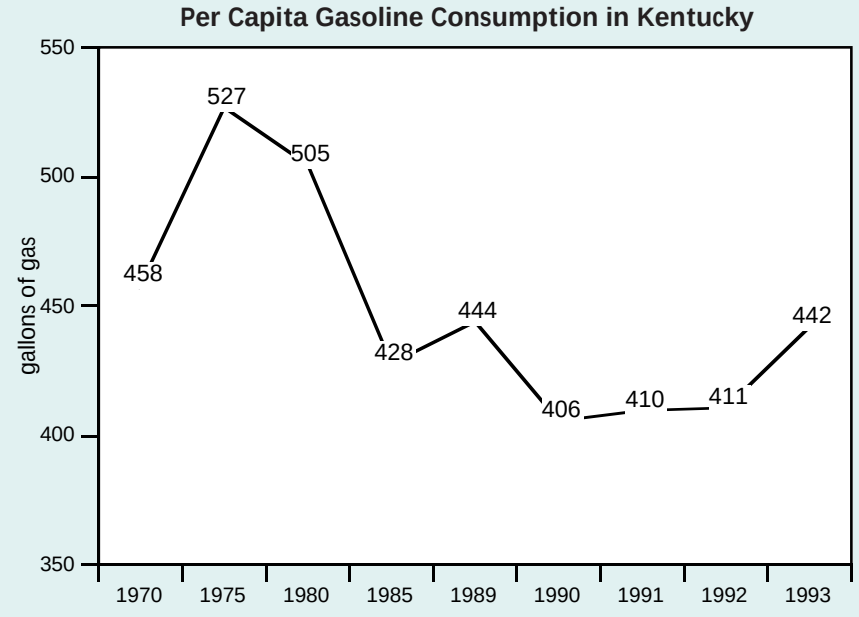
Source: State Data Center, U.S. Census, 1994

Despite some efforts to encourage carpooling, most Kentuckians drive alone to work. The number of people using personal vehicles for work-related transportation increased 64% from 1970 and 1990. This may reflect the growing number of women in the work force (760,458 in 1990 compared to 414,089 in 1970) and rural citizens who commute to urban areas. Carpooling became popular in the 1970's due to a sharp rise in gasoline prices and federal and state incentives to encourage ride-sharing. However, funding cuts in energy conservation programs during the 1980's, stabilized gasoline prices, and an increase in the number of Kentuckians with automobiles have likely resulted in the decline in carpooling.

Figure 9

Personal Transportation Trends in Kentucky





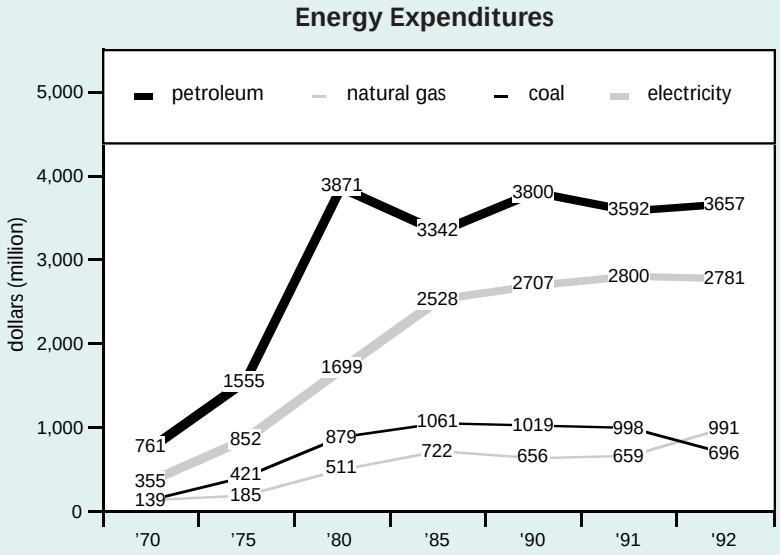
Source: U.S. Department of Energy, EIA State Energy Data Reports 1970-93; Kentucky Department of Transportation, 1994

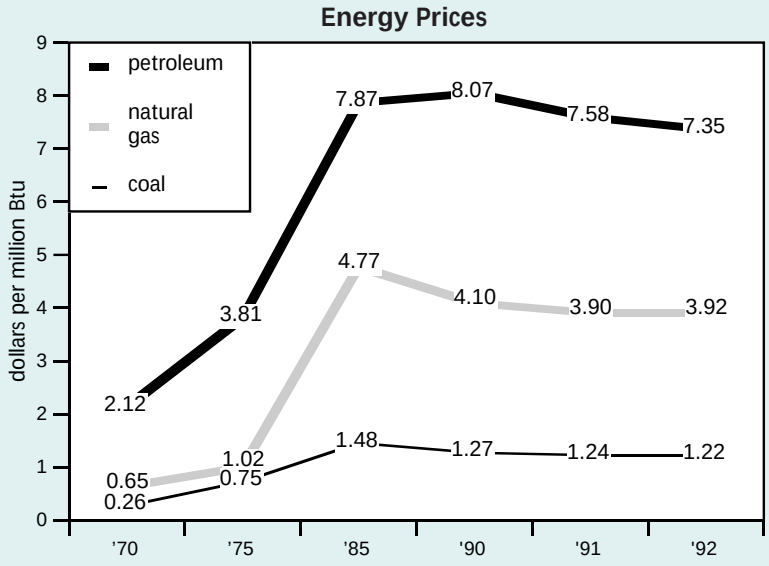
In 1993, 1.8 million passenger vehicles were registered in the state, a 35% increase since 1970. Kentuckians have also nearly doubled the average number of vehicle miles traveled annually since 1970. Although per capita miles traveled has increased, per capita gasoline consumption has declined since 1975 due to improved fuel efficiency in automobiles and other vehicles. Indicators reveal that auto mileage averaged 13 miles per gallon of gasoline in 1975 compared to 23 miles per gallon in 1993. Fuel efficiency in personal travel is predicted to increase 44% by the year 2010 due to new technologies, federal incentives, and other factors, according to the U.S. Department of Energy.

III. Energy Price and Expenditure Indicators

Figure 10

Energy Costs in Kentucky





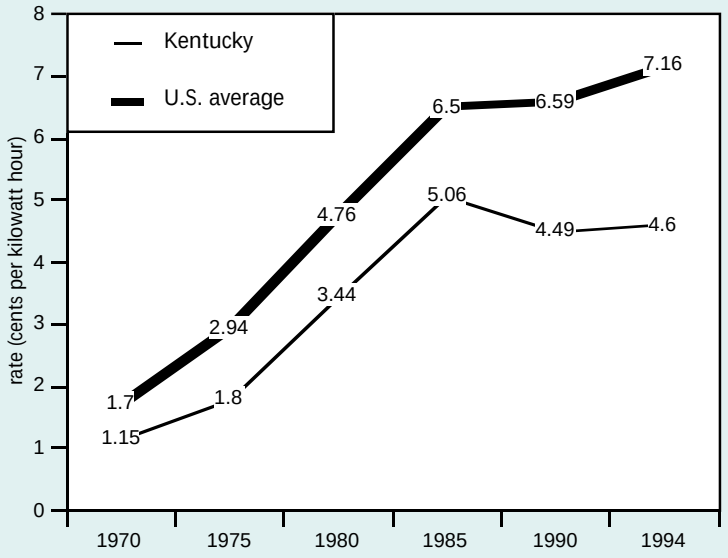
Source: U.S. Department of Energy, EIA State Energy Data Reports, 1970-92

Kentuckians have spent more than $7 billion during each of the last several years to provide energy for commercial, residential, transportation, and industrial activities. The average Kentuckian spends about seven percent of their income on energy consumption, according to the Kentucky Public Service Commission.

Energy prices rose 207% between 1975 and 1985 for petroleum and natural gas contributing to the energy crisis at that time. Energy costs have since stabilized or declined in recent years in response to market conditions and competition. The price of coal remained generally stable during the 1980's and early 1990's and remains Kentucky's lowest-priced fuel. However, when adjusted for inflation, coal and other energy prices declined during that time.

Figure 11

Average Electric Rates in Kentucky

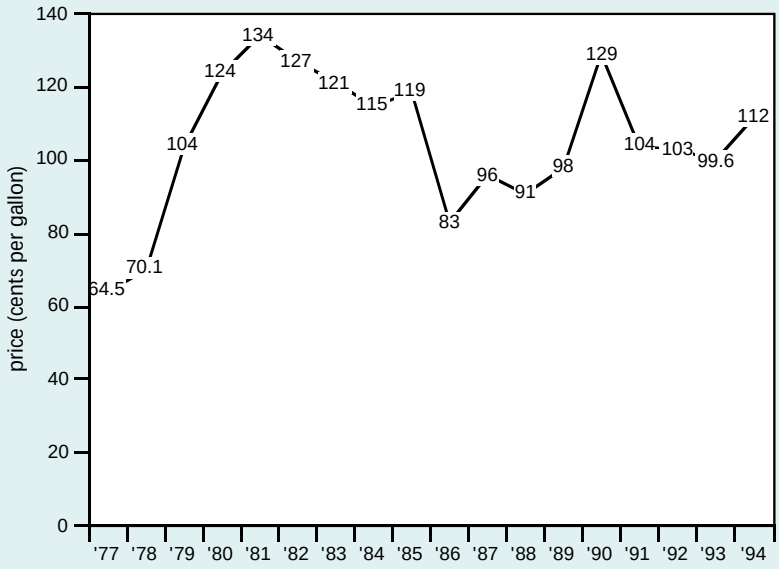


Note: Data represents average electric rates for all use sectors.
Source: U.S. Department of Energy, EIA State Energy Data Reports, 1970-94

Kentucky has some of the lowest electric rates in the nation primarily due to the state's proximity to coal resources. Electric rates in Kentucky were well below the national average during the last two decades. Experts anticipate that electric rates will increase more than 4% in the state by the year 2004 due to the costs associated with reducing sulfur dioxide emissions from coal-fired power plants.

Figure 12

Gasoline Price Trends in Kentucky

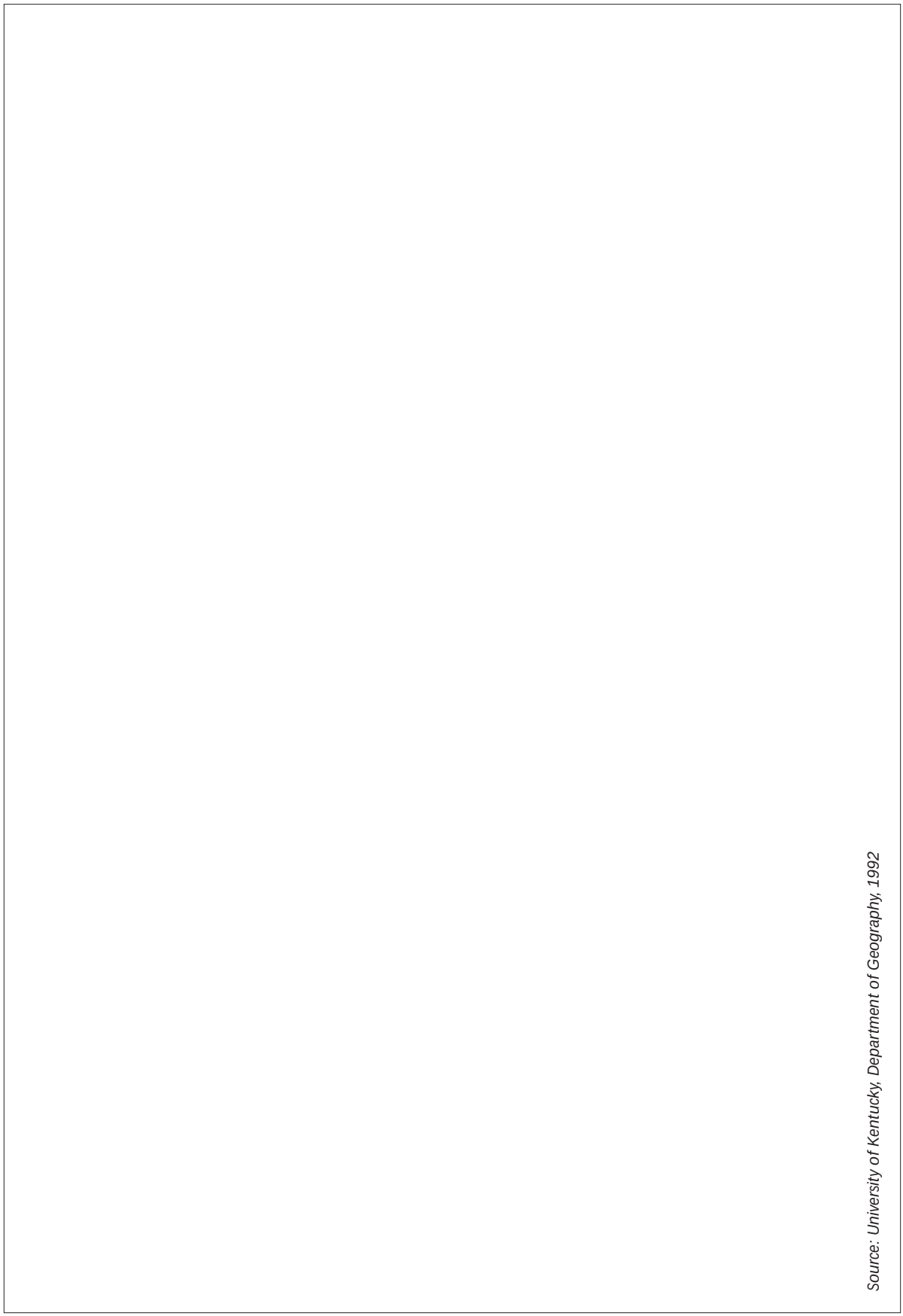


Note: Prices are based on average pump costs on December 17th for self-serve, regular unleaded gasoline.
Source: American Automobile Association, Louisville Office, 1994

Gasoline prices vary throughout the state and rise and fall due to many factors such as supply shortages and demand. Average gasoline prices have remained fairly stable since 1991 but increased in 1994 due to market conditions and a 4.3 cent federal tax increase which took affect in late 1993. The use of reformulated gas to reduce automobile emissions in Louisville, Northern Kentucky, and Ashland, is expected to increase average gas prices five to ten cents.

Appendices

Appendix A. County Reference Map



Source: University of Kentucky, Department of Geography, 1992

Appendix B. Bibliography

WATER

"Assessment of Needs for Publicly Owned Wastewater Treatment Facilities, Correction of Infiltration/Inflow, and Correction of Combined Sewer Overflows," Kentucky 1994 Needs Survey, Natural Resources and Environmental Protection Cabinet, Division of Water, 14 Reilly Road, Frankfort, KY 40601, 1995.

"Draft Strategic Plan," Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water, October 1994.

"Something in the Water," Rob Gurwitt, Governing, Congressional Quarterly Incorporated, 2300 N Street Northwest, Suite 760, Washington, DC 20037, September 1994.

"ORSANCO - Working to Improve Water Quality of the Ohio River," ORSANCO Outlook, 5735 Kellogg Avenue, Cincinnati, OH 45228-1112, Fall 1994.

"Public Water Supply Waterline Extension and Tap-on Sanction Status," Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water, Drinking Water Branch, August 1994.

"Proposed Rule to Protect Drinking Water from Disinfection Byproducts," Activities Update, United States Environmental Protection Agency, Communications, Education, and Public Affairs, Agency 1702, Washington, DC 20460, July 1994.

Selected OWAS Data Sheet, United States Environmental Protection Agency, Office of Water Enforcement and Permits, June 1994.

Regionalization of Wastewater Treatment Facilities in Kentucky - Progress, Problems, and Recommendations, compiled by Laura Risler, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water, June 1994.

"Health Department Advises Missourians on Fish Safety," Missouri Department of Health, P.O. Box 570, Jefferson City, MO 65102, June 1994.

"Safe Drinking Water - Policy, Perceptions, and Science," Water Science Reporter, National Institutes for Water Resources, New Mexico State University, Box 30001, Department 3167, Las Cruces, NM 88003, Spring 1994.

"How Safe Is Your Drinking Water," Andrew Melnykovych, The Courier-Journal, 525 West Broadway, Louisville, KY 40201-7431, May 23, 1994.

"Wellhead Protection - An Overview for Kentucky," Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water, Groundwater Branch, April 1994.

"Victorian Water Treatment Enters the 21st Century, Public Health Threats From Water Utilities' Ancient Treatment and Distribution Systems," Brian A. Cohen and Erik D. Olson, Natural Resources Defense Council, 40 West 20th Street, New York, NY 10011, March 1994.

"Louisville Ponders Using Wells to Filter River Water," Andrew Melnykovych, The Courier-Journal, February 22, 1994.

"State Warns About Green River Lake Fish," The Lexington Herald-Leader, 100 Midland Avenue, Lexington, KY 40508, February 12, 1994.

1989 through 1993 Kentucky Public Water System Statistics, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water, 1994.

1980 through 1994 Kentucky Reports to Congress on Water Quality, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water, 1994.

1970 through 1993 Kentucky Water Withdrawal Permittee Statistics, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Water, 1994.

"Water in Kentucky - Fact Sheet," David R. Wunsch, Daniel I. Carey, and James S. Dinger, Kentucky Geological Survey, 228 Mining and Mineral Resources Building, University of Kentucky, Lexington, KY 40506, October 1993.

Think Before You Drink, Erik D. Olson, Natural Resources Defense Council, September 1993.

"Waterborne Pathogens: Assessing Health Risks," Health and Environment Digest, Freshwater Foundation at Spring Hill Center, 725 County Road 6, Wayzata, MN 55391, June 1993.

Quality of Private Ground-Water Supplies in Kentucky, Kentucky Geological Survey, 1993.

AIR

"300 Evacuated After Second Chemical Leak in Week," Eric Gregory, Lexington Herald-Leader, 100 Midland Avenue, Lexington, KY 40508, November 17, 1994.

"Kentucky Utilities Comes Face-To-Face with Competition," Alan I. Kirschenbaum, The Lane Report, Lane Communications Group, 269 West Main Street, Lexington, KY 40507, September 1994.

Kentucky Ambient Air Quality Annual Reports 1975 through 1993, Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division for Air Quality, 803 Schenkel Lane, Frankfort, KY 40601, August 1994.

"State Camcorders to View Ashland Oil Operations," The State Journal, 321 West Main, Frankfort, KY 40601, April 3, 1994.

Ambient Sulfate and Hydrogen Ion Data - 1985 through 1993, National Acid Deposition Program, Central Analytical Laboratory, Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL 61820, 1994.

Emissions, Enforcement, Compliance, Complaints, and Permit Data - 1980 through 1993, Jefferson County Air Pollution Control District, 850 Barret Avenue, Louisville, KY 40204, 1994.

Emissions, Enforcement, Compliance, Complaints, and Permit Data - 1980 through 1993, Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, 14 Reilly Road, Frankfort, KY 40601, 1994.

National Air Quality Emissions Trends Report, 1992, United States Environmental Protection Agency, Office of Air Quality, Planning and Standards, Research Triangle Park, NC 27711, October 1993.

"Decision on Anti-Smog Gasoline Is Mixed News for Ethanol Industry," Michael Weisskopf, The Washington Post, The Courier-Journal, 525 West Broadway, Louisville, KY 40201-7431, December 15, 1993.

"State Says Air Improving in Four Areas, Wants Them Taken Off Hazardous List," Associated Press, The Courier-Journal, December 14, 1993.

"Catching Some Rays," Editorial, The Courier-Journal, December 6, 1993.

"Agency Gives Farmers One-Year Extension on the Use of Fumigant," Rita Beamish, Associated Press Writer, The State Journal, December 1, 1993.

EPA's Map of Radon Zones - Kentucky, United States Environmental Protection Agency, Washinton DC 20460, September 1993.

"Louisville Air Quality Continues to Improve," Andrew Melnykovych, The Courier-Journal, July 22, 1993.

"Source Allocation Report for Sulfur Dioxide, Nitrogen Dioxide, Particulates, Lead, Volatile Organic Chemicals, Carbon Monoxide," Emissions Inventory System, Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division for Air Quality, July 1993.

1992 Report to Congress, National Acid Precipitation Assessment Program, 1110 Vermont Avenue, Northwest, Suite 810, Washington, DC 20005, 1993.

Precipitation Chemistry in the United States, 1993, National Atmospheric Deposition Program, Coordination Office, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523, 1993.

Breath in Danger II, American Lung Association, 1740 Broadway, New York, NY 10019-4374, 1993.

WASTE MANAGEMENT

Hazardous Waste

"Environmentalists Again Try to Close Liquid Waste Disposal (LWD) Incinerator," James Malone, The Courier-Journal, 525 West Broadway, Louisville, KY 40201-7431, June 22, 1994.

"1981 through 1993 Kentucky Hazardous Waste Generators Annual Report," Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, 1994.

"List of Superfund Sites," Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, Superfund Branch, July 26, 1993.

Solid Waste

"Municipal Solid Waste Management Reduction Status Report - Landfills," Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, 14 Reilly Road, Frankfort, KY 40601, November 1994.

"Counties Join Forces to Fulfill 1997 Recycling Goal," Land, Air, and Water, Kentucky Natural Resources and Environmental Protection Cabinet, Office of Communications and Community Affairs, Capital Plaza Tower, 500 Mero Street, Frankfort, KY 40601, Fall 1994.

The Planning Edge, Bulletin on Solid Waste Planning, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, Issue No. 13, July 1994.

List of All Residual, Inert, and Construction Demolition Debris Landfills, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, Solid Waste Branch, July 1994.

Summary Report of All Municipal Waste by Source, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, Solid Waste Branch, July 1994.

List of Various Special Waste Activities, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, Solid Waste Branch, July 1994.

Data From Solid Waste Management Plans and Annual Reports, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, June 1994.

Area Solid Waste Management Plan, Annual Report (for 120 Kentucky counties), Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, March 1994.

Solid Waste Plan Information, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, 1994.

Recycling Issues Paper for 1994 Proposed Legislation, prepared by the Kentucky Natural Resources and Environmental Protection Cabinet, November 1993.

1993 Annual Report to the General Assembly, Kentucky Cabinet for Economic Development, Kentucky Recycling Brokerage Authority, Capital Plaza Tower, 500 Mero Street, Frankfort, KY 40601, July 1993.

"Surveillance of Aedes albopictus in Kentucky - Research Proposal," Department of Entomology, S 225 Agriculture Science Building, University of Kentucky, Lexington, KY 40545-0091, June 1993.

1993 County Annual Report Summary, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, 1993.

Report on Current Landfill Status and Solid Waste Planning - Presented to Budget Review Subcommittee on Development, Natural Resources and Tourism, Interim Joint Committee on Appropriations and Revenue, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, August 1992.

Statewide Solid Waste Reduction and Management Plan, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Waste Management, March 1992.

Medical Waste

"Suit Over Floyd Incinerators Expanded," Associated Press, The Courier-Journal, October 26, 1994.

"Medical Incinerators Are Subject of Lawsuit," Associated Press, The State Journal, October 26, 1994.

"1994 Database - Pathological Waste Incinerators," Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division for Air Quality, 803 Schenkel Lane, Frankfort, KY 40601, July 1994.

Low-Level Radioactive Waste
"Paducah Plant Understated Amount of Uranium Released," James Malone, The Courier-Journal, February 14, 1995.

"State Official Backs Plan to Clean Up Oil Field," Associated Press, The Courier-Journal, September 16, 1994.

"Low-Level Waste Activities at the Department of Energy Paducah Gaseous Diffusion Plant," Jimmie C. Hodges, Site Manager, United States Department of Energy, Oak Ridge Operations, Paducah Site Office, P.O. Box 1410, Paducah, KY 42001, September 1994.

"Paducah Plant Released 345 Pounds of Uranium in 1993," James Malone, The Courier-Journal, July 9, 1994.

"Dumping Outsiders - Low-level Nuclear-Waste Landfill Closes to Many States," Frank Clifford, Los Angeles Times, The Courier-Journal, June 5, 1994.

"State Unveils Plan to Test Radioactivity in Oil Fields," Associated Press, The Courier-Journal, February 24, 1994.

"State Set to Test Oil Field for Natural Radiation," Allen G. Breed, Associated Press Writer, The State Journal, 321 West Main, Frankfort, KY 40601, February 24, 1994.

"Scoping Report on Naturally Occurring Radioactive Material from Oil Field Production," Kentucky Human Resources Cabinet, Radiation Control Branch, 275 East Main Street, Frankfort, KY 40621, February 1994.

"Paducah Gaseous Diffusion Plant, Annual Site Report for 1993," Martin Marietta Energy Systems, Inc., P.O. Box 2008, Oak Ridge TN 37831-6285, October, 1994

"Deep Trouble - Radium from Oil and Gas Wells Poses Threat," Andrew Melnykovych, The Courier-Journal, May 24, 1993.

TOXICS

1992 through 1994 Blood Lead Monitoring of Kentucky Children, Human Resources Cabinet, Department for Health Services, 275 East Main Street, Frankfort, KY 40621, February 1995.

Supplemental Environmental Projects Data, Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, 14 Reilly Road, Frankfort, KY, November 1994.

1988 through 1992 Toxic Release Inventory, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics, 401 M Street, Southwest (7407), Washington, DC 20460, April 1994.

"Chemical Plants Must Meet Tougher EPA Pollution Rules, The H. Josef Herbert, Associated Press, The Courier-Journal, 525 West Broadway, Louisville, KY 40201-7431, March 2, 1994.

"Debate Continues on Incineration of Weapons Despite Council Ruling," Associated Press, The Courier-Journal, February 15, 1994.

"The Risks of Risk Assessment," The Ohio Environmental Report, The Newsletter of the Ohio Environmental Council, 400 Dublin Avenue, Suite 120, Columbus, OH 43215, March/April 1994.

"The Status of Environmental Risk Assessments in Kentucky," Environmental Newsline, Kentucky Chamber of Commerce, P.O. Box 817, Frankfort, KY 40602-0817, Volume 5, Issue 9, 1994.

"Report Says State Lax in Protecting Children From Lead," Andrew Melnykovych, The Courier-Journal, September 17, 1993.

Measuring the Success of Source Reduction of TRI Chemicals and Draft Criteria for Evaluating Waste Minimization Projections in States' Capacity Assurance Plans, National Advisory Council for Environmental Policy and Technology, Environmental Measurements and Chemical Accident Prevention Committee, Pollution Prevention Measurements Subcommittee, U.S. Environmental Protection Agency, January 1993.

Case Studies in Environmental Medicine - Lead Toxicity, United States Department of Health and Human Services, Public Health Service, Centers for Disease Control, Agency for Toxic Substances and Disease Registry, Division of Health Education, E33, 1600 Clifton Road, Northeast, Atlanta, GA 30333, September 1992.

NATURAL RESOURCES

Agriculture
Proposed Consent Decree on Lawsuit Concerning Pesticides and the Delaney Clause, United States Environmental Protection Agency, Environmental News, Communications, Education, and Public Affairs, Washington, DC 20460, October 1994.
1980 through 1994 Kentucky Agricultural Statistics, prepared by Kentucky Agricultural Statistics Service, P.O. Box 1120, Louisville, KY 40201-1120, September 1994.

1992 through 1994 - Number of Conservation District Cooperators, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Natural Resources, Division of Conservation, 691 Teton Trail, Frankfort, KY 40601, 1994.

Fourth Quarter Report (year end) - Groundwater, Worker Protection, Endangered Species, Kentucky Department of Agriculture, Division of Pesticides, Special Projects Branch, 500 Mero Street, Frankfort, KY 40601, 1994.

1982 through 1992 Census of Agriculture, United States Department of Commerce, Agriculture Division, Bureau of the Census, Washington, DC 20233, 1993.

Summary Report 1992 National Resources Inventory, United States Department of Agriculture, Soil Conservation Service, 1993.

Quality of Private Ground-Water Supplies in Kentucky, Kentucky Geological Survey, 288 Mining and Mineral Resources Building, University of Kentucky, Lexington, KY 40506, 1993.

Assessment of Water Quality Conditions - Ohio River Main Stem - Water Years 1992-1993, prepared by the Ohio River Valley Water Sanitation Commission as a Supplement to the Reports prepared by the States of Illinois, Indiana, Kentucky, Ohio, Pennsylvania, West Virginia, 5735 Kellogg Avenue, Cincinnati, OH 45228-1112, 1993.

Fourth Quarter Report (year end) - Groundwater, Worker Protection, Endangered Species, Kentucky Department of Agriculture, Division of Pesticides, Special Projects Branch, 1993.

Forestry
"Growth in Wood Manufacturing Hinges on Existing Businesses, Report Says," Allen G. Breed, Associated Press, The Courier-Journal, 525 West Broadway, Louisville, KY 40201-7431, October 26, 1994.

Timber Harvest Trends Daniel Boone National Forest, United States Forest Service, Daniel Boone National Forest, 100 Vaught Road, Winchester, KY

40391, August 1994.

"Kentucky's Forest Resources," prepared by William H. Martin, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Natural Resources, 107 Mero Street, Frankfort, KY 40601; Mark Matuszewski, Kentucky Division of Forestry, 627 Comanche Trail, Frankfort, KY 40601; Robert N. Muller, University of Kentucky Department of Forestry, Thomas Poe Cooper Building, Lexington, KY 40546; Bradley E. Powell, Daniel Boone National Forest, March 1994.

"Group Linked to Loggers Urges Continued Clear-Cutting at Land Between the Lakes," James Malone, The Courier-Journal, January 11, 1994.

Forestry Incentives Program - From Inception of Program Through 1993 Fiscal Year, United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Washington, DC 20250, January 1994.

1985 through 1994 Seedling Distribution Report, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Natural Resources, Division of Forestry, 1994.

Staffing and Funding Plan - 1994 through 2000, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Natural Resources, Division of Forestry, September 1993.

1988 through 1993 Fourth Quarter - Stumpage Price Mart - Standing Timber, Timber Mart-South, Box 1278 Highlands, NC 28741.

1970 through 93 Fire Occurrence Report, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Natural Resources, Division of Forestry.

Wildlife

National Breeding Bird Survey, Bruce Peterjohn, Patuxent Environmental Science Center, 12100 Beech Forest Road, Laurel, MD 20708, January 1995.

"Critics Rap Plan to Log Between the Lakes," James Malone, The Courier-Journal, October 19, 1994.

"Plants and Animals Presumed Extinct or Extirpated from Kentucky," Kentucky State Nature Preserves Commission, 801 Schenkel Lane, Frankfort, KY 40601, October 1994.

"Daniel Boone Plan Aims to Preserve Rare Woodpecker," Allen G. Breed, Associated Press, Lexington Herald-Leader, 100 Midland Avenue, Lexington, KY 40508, September 9, 1994.

Endangered Species: Technical Bulletin, Vol. XIX No.4, United States Department of Interior, Fish and Wildlife Service, Washington, D.C. 20240, July/August 1994.

Grouse Census/Statewide Range, Jeffery Sole, Upland Game Program, Kentucky Tourism Cabinet, Department of Fish and Wildlife Resources, #1 Game Farm Road, Frankfort, KY 40601, July 1994.

"State Buying Woods in Harlan for Preserve," The Courier-Journal, April 15, 1994.

"Use of Land Between the Lakes Being Re-examined," James Malone, The Courier- Journal, March 8, 1994.

"Survey of Least Tern Nesting Colonies in Kentucky," Brainard Palmer-Ball, Jr., submitted to Kentucky Department of Fish and Wildlife Resources by the Kentucky State Nature Preserves Commission, 1994.

"1993-94 Ruffed Grouse Restoration Annual Report," Jeffery Sole, Upland Game Program, Kentucky Tourism Cabinet, Department of Fish and Wildlife Resources, 1994.

"Pondering Kentucky's Rare, Threatened, and Endangered Species," Phil Glass, Kentucky Afield - The Magazine, Kentucky Tourism Cabinet, Department of Fish and Wildlife Resources, January-February 1992.

"Musseling In Kentucky - The First 200 Years," Edwin F. Crowell and Benjamin T. Kinman, Kentucky Tourism Cabinet, Department of Fish and Wildlife Resources, 1992.

RESOURCE EXTRACTION

"Field Survey of the Martha Oil Field," Rice C. Leach, M.D., Kentucky Cabinet for Human Resources, Department for Health Services, 275 East Main Street, Frankfort, KY 40621, November 1994.

"Demand for Coal Is Balancing Supply," Associated Press, The Courier-Journal, 525 West Broadway, Louisville, KY 40201-7431, October 10, 1994.

"Back to Nature - Strip Mine Reclaimed with Wildflowers, Prairie Grass," Kirsten Haukebo, The Courier-Journal, July 11, 1994.

Natural Gas 1994 Issues and Trends, United States Department of Energy, Office of Oil and Gas, Energy Information Administration, Forrestal Building, Room 1F-048, Washington, DC 20585, July 1994.

Oil and Gas Drilling Activity Summary for Kentucky 1993, Brandon C. Nuttall, Kentucky Geological Survey, 228 Mining and Mineral Resources Building, University of Kentucky, Lexington, KY 40506, Information Circular 50, Series XI, 1994.

Draft Twelfth Annual Report - July 1, 1993 through June 30, 1994, United States Department of the Interior, Office of Surface Mining Reclamation and Enforcement, for the Regulatory and Abandoned Mine Land Reclamation Programs, administered by the Commonwealth of Kentucky, Natural Resources and Environmental Protection Cabinet, Department for Surface Mining Reclamation and Enforcement, Division of Abandoned Lands, #2 Hudson Hollow, Frankfort, KY 40601, 1994.

1st through 11th Annual Reports, Natural Resources and Environmental Protection Cabinet, Department for Surface Mining Reclamation and Enforcement, Division of Abandoned Lands.

"Western Kentucky May Hold Major Gas Field, Report Says," Greg Otolski, The Courier-Journal, December 8, 1993.

Kentucky Coal Facts, 1993-1994 Pocket Guide, Kentucky Cabinet for Economic Development, Kentucky Coal Marketing and Export Council, 500 Mero Street, 2100 Capital Plaza Tower, Frankfort, KY 40601, and the Kentucky Coal Association, 340 South Broadway, Lexington, KY 40508, December 1993.

"Abandoned-Tank Disposal is Costly, Therefore Unlikely," James Malone, The Courier-Journal, November 29, 1993.

"Coal in Kentucky - Fact Sheet," compiled by Robert E. Andrews, Kentucky Geological Survey, October 1993.

"Oil and Gas in Kentucky - Fact Sheet," compiled by Brandon C. Nuttall, Kentucky Geological Survey, September 1993.
Reclamation Bonding Study - Kentucky Permanent Program - Joint

Steering Committee Findings, commissioned by the Kentucky Department for Surface Mining Reclamation and Enforcement, July 1993.

1992 and 1993 Annual Report, Kentucky Public Protection and Regulation Cabinet, Department of Mines and Minerals, 3572 Iron Works Pike, Lexington, KY 40512, 1993.

ENERGY

"Louisville Gas & Electric Company Seeks Higher Electric Rates," The Courier-Journal, 525 Broadway, Louisville, KY 40201, February 3, 1995.

"Green Fleets," Sarah Lynn Cunningham, Louisville and Jefferson County Metropolitan Sewer District, 400 South Sixth Street, Louisville, KY 40202-2397, December 1994.

"Energy Policy Act of 1992 - Provisions Requiring State Action & Opportunities for States," compiled by Kentucky Division of Energy, Natural Resources and Environmental Protection Cabinet, Division of Energy, 691 Teton Trail, Frankfort, KY 40601, November 1994.

Gasoline Prices in Kentucky, American Automobile Association of Kentucky, 435 E. Broadway, Louisville, KY 40202, November 1994.

Program Focus/Funding & Energy Fact Sheet, Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Energy, October 26, 1994.

Energy - Our Future is Today, Energy Awareness Month October 1994, United States Department of Energy, 1000 Independence Avenue, Southwest, Washington, DC 20585, October 1994.

"Louisville Joins Clean Cities Program," Conservation Update, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Energy, October 1994.

"Recommendations to Meet Requirements of the Energy Policy Act of 1992 - State Purchases of Alternative Fuel Vehicles," Kentucky Natural Resources and Environmental Protection Cabinet, John Stapleton, Division of Energy, September 1994.

Summary of the Climate Change Action Plans, National Association of State Energy Officials, 1615 M Street Northwest, Suite 810, Washington, DC 20036, September 1994.

"Plugging Into Electricity's Future", Coal Voice, 1130 17th Street, Northwest, Washington, DC 20036-4677, Volume 17:4, Fall 1994.

Saving Energy in United State Transportation, United States Congress, Office of Technology Assessment, Washington, DC 20510-8025, July 1994.

Reducing Home Heating and Cooling Costs, Energy Information Administration, National Energy Information Center, EI-231, Forrestal Building, Room 1F-048, Washington, DC 20585, July 1994.

"Louisville Area Joins Effort to Cut Pollution Tied to Transportation," Andrew Melnykovych, The Courier-Journal, April 12, 1994.

Kentucky State Energy Conservation Plan submitted to the United States Department of Energy by the Kentucky Natural Resources and Environmental Protection Cabinet, 500 Mero Street, Frankfort, KY 40601, April 1994.

"Assessing the Competition," Coal Voice, Volume 17:2, Spring 1994.

Electric Utility Phase I Acid Rain Compliance Strategies for the Clean Air Act Amendments of 1990, Energy Information Administration, March 1994.

Staff Report from the Statewide Perspective on the 1993 Integrated Resource Plans of the Major Jurisdictional Electric Utilities in Kentucky, Kentucky Public Protection and Regulation Cabinet, Public Service Commission, 730 Schenkel Lane, Frankfort, KY 40602, February 1994.

Biennial Report, July 1, 1991 through June 30, 1993, Kentucky Public Protection and Regulation Cabinet, Public Service Commission, January 1994.

Taking an Alternative Route, United States Department of Energy, Office of Transportation Technologies, 1994.

1987 through 1993 Primary Industry Production of Mill Residue for Kentucky, Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Forestry, 1994.

"Activity Data on Air Traffic at Standiford and Bowman Fields," Regional Airport Authority, Louisville and Jefferson County, P.O. Box 9129, Louisville, KY 40209, 1994.

"Demand-Side Management Actions Promoted," Conservation Update, State Energy Conservation Program, Energy Extension Service, Kentucky Natural Resources and Environmental Protection Cabinet, Division of Energy, December 1993.

"Clean Fuels Conference Held in Louisville by the Kentucky Clean Fuels Coalition," The Kentucky City - newsletter, Kentucky League of Cities, 2201 Regency Road, Suite 100, Lexington, KY 40503, November 1993.

"Energy Efficient Lighting Products," Kentucky Natural Resources and Environmental Protection Cabinet, Division of Energy, United States Environmental Protection Agency, Assistance I.D. Number CX 817506-01-0, June 1993.

State Energy Price and Expenditure Report 1992, Energy Information Administration, 1993.

Kentucky Energy Digest, Kentucky Natural Resources and Environmental Protection Cabinet, Department for Environmental Protection, Division of Energy, Volume 2, Number 4, Summer 1992; Volume 3, Number 2, Winter 1992/1993; Volume 3, Number 4, Summer 1993.

"Sustainable Development and Cheap Electricity," Mark P. Mills, Mills McCarthy Associates, Inc., 6900 Wisconsin Avenue, Suite 700, Chevy Chase, MD 20815, October 1992.

Utilities Operating in the State of Kentucky and Reporting to the Public Service Commission of Kentucky, Public Protection and Regulation Cabinet, Public Service Commission, Rates and Research Division, July 1992.

State Energy Price and Expenditure Report 1991, Energy Information Administration, 1992.

"Shaping Demand-Side Management As a Resource," Leslie Lamarre, EPRI Journal, Electric Power Research Institute, P.O. Box 10412, Palo Alto, CA 94303, October/November 1991.

"Employment Status and Journey to Work Characteristics: 1990 - Kentucky," Center for Urban and Economic Research, Kentucky State Data Center, University of Louisville, Louisville, KY 40292, 1991.

GENERAL

Kentucky Annual Economic Report 1995, Center for Business and Economic Research, Department of Economics, College of Business and Economics, University of Kentucky, 303 Mathews Building, Lexington, KY 40506-0047, 1995.

Economic Data, Kentucky Cabinet for Human Resources, Department for Employment Services, 275 East Main Street, Frankfort, KY 40621, December 1994.

"Conversion Factor - To Convert Data for a Particular Year to 1994 Dollars," Manou Shanker, Finance and Administration Cabinet, Office of Financial Management and Economic Analysis, 261 Capitol Annex, Frankfort, KY 40601-3453, October 1994.

"Regional Economic Information, Employment by Major Sector - Kentucky," Center for Urban and Economic Research, Kentucky State Data Center, University of Louisville, Louisville, KY 40292, May 1994.

1994 Kentucky Deskbook of Economics Statistics, Cabinet for Economic Development, Division of Research, 2400 Capital Plaza Tower, 500 Mero Street, Frankfort, KY 40601, 1994.

State of Kentucky, Executive Budgets 1980 through 1994, Kentucky Governor's Office for Policy and Management, Capitol Annex, Frankfort, KY 40601.

1980 and 1990 United States Census, Center for Urban and Economic Research, Kentucky State Data Center.

Appendix C. Index